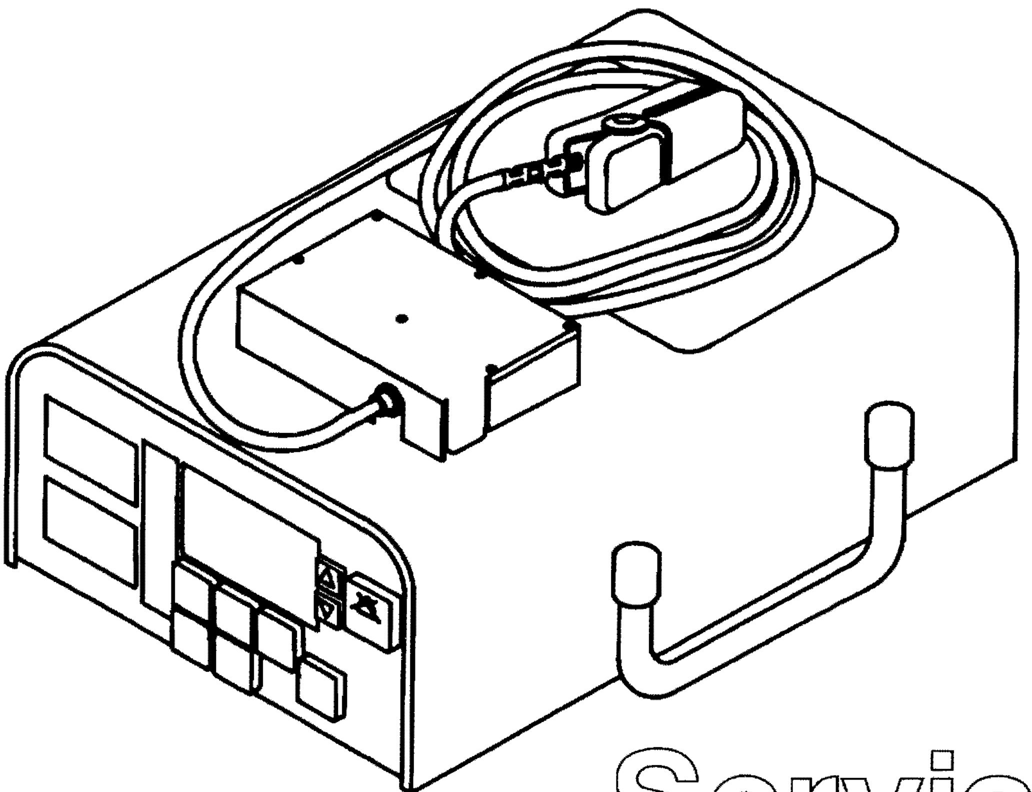
9522

INVIVO PULSE OXIMETER

4500™ MRI



Service Manual

INVIVO RESEARCH INC.
12601 RESEARCH PARKWAY • ORLANDO, FLORIDA 32826

Invivo Pulse Oximeter
Model 4500 MRI
Service Manual

MANUAL BY:
Lloyd L. Shoemaker
Technical Publications

EDITED BY:
Tom W. Foshee
Director of Quality Assurance

IRI PN# 9522

Release 2, 7/93
ECN # 3567

INVIVO
RESEARCH
INCORPORATED

12601 Research Parkway
Orlando, FL 32826
1-800-331-3220

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF DRAWINGS

PRECAUTIONS

WARNING

A complete understanding of the following precautions is essential for safe operation of this equipment. Invivo Research highly recommends that all operator's and service personnel read this section carefully.

Do not place the probe on the same limb with an inflated blood pressure cuff. Cuff inflation could result in inaccurate readings and false alarm violations.

The monitor is not intended for use in the presence of flammable anesthetics. **AN EXPLOSION HAZARD EXISTS.**

Never immerse the unit in any fluid or attempt to clean it with liquid cleaning agents. **AN ELECTRICAL HAZARD EXISTS.**

Do not use a monitor that has failed to respond as described herein. Refer to qualified service personnel. No repair should be undertaken or attempted by anyone not having a thorough understanding of the repair of pulse oximeters. Federal law in the U.S.A. and Canada restricts this device to sale by or on the order of a licensed medical practitioner.

Pulse Oximeters require detection of valid pulse to correctly determine saturation and rate values. This monitor incorporates both audible and visual pulse indicators. The pulse bar on the 4500 MRI or the pulse waveform on the Omni-Trak screen should be used as an indication of interference. Normal (noise free) signals will cause a smooth rhythmic pulse bar or waveform pattern.

Excessive noise can cause erroneous readings.

The 4500 Pulse Oximeter is calibrated to read arterial hemoglobin oxygen saturation of functional hemoglobin (saturation of hemoglobin functionally available for transporting oxygen in the arteries). Significant levels of dysfunctional hemoglobins such as carboxyhemoglobin or methemoglobin may affect the accuracy of the measurement. Also, cardiogreen and other intravascular dyes may, depending on concentration, affect the accuracy of the measurement.

Sensor should be shielded from excessive extraneous incident light sources. Such extraneous light can cause reading error or pulse detection failure.

Frequent medical attention to sensor site for possible pressure tissue necrosis should be given during longer term monitoring sessions. Special care should be exercised when tape is used to secure the sensor, as the stretch memory property of most tapes can easily apply unintended levels of pressure to the mounting site.

The Model 3109-1 4500 MRI Oximeter draws power from the Omni-Trak 3100 system but also has its own power "On" button. Alarms may be set locally on the oximeter or the Omni-Trak, but the settings are independent of each other. The 3109-3 is stand alone and are powered by a wall outlet transformer.

Glass fiber sensor cable is fragile. The Optic Sensor cable should never be flexed or bent at extreme angles to avoid breaking fiber optic strands within the cable. Use proper care to not pinch or step on cable. Take extreme care to loop cable neatly for storage, all bends in cable should have larger than a three (3) inch radius.

Finally, as with all items placed in the bore, assure that cable runs straight out the bore and at least 4 inches from any other cable. The patient's finger or toe should not pin the sensor close to the side of the bore. Be sure to inspect all equipment for damage before and after each use.

USER RESPONSIBILITY

This product will perform in conformity with the description thereof contained in this operating manual and accompanying labels and/or inserts, when assembled, operated, maintained, and repaired in accordance with the instructions provided.

This product must be checked periodically for proper operation. A defective or questionable product should not be used. Parts that are broken, missing, plainly worn, distorted, or contaminated should be replaced immediately.

Should such repair or replacement become necessary, Invivo Research Incorporated (IRI) recommends that a telephone call or written request for service be made to the factory or nearest service center. IRI's toll free number is: (800) 331 - 3220, ask for Technical Assistance.

This product or any of its parts should not be repaired other than in accordance with written instructions provided by IRI or altered without the prior written approval of IRI.

The user of the product shall have the sole responsibility for any malfunction which results from improper use, faulty maintenance, improper repair, damage, or alteration by anyone other than IRI or IRI authorized service personnel.

SPECIFICATIONS

PARAMETER	SPECIFICATION
Saturation Accuracy	100 - 90%, ±2.0% 90 - 80%, ±2.2% 80 - 70%, ±2.5% 70 - 60%, ±2.8% 60 - 50%, ±3.3%
Pulse Rate Range	20 - 250 bpm
Pulse Display	Pulse-Trak™ moving light bar
Alarm Ranges	High Saturation: 70 to 100% Low Saturation: 50 to 100% High Pulse Rate: 50 to 250 bpm Low Pulse Rate: 40 to 180 bpm
Alarm Modes	Latched and Non-latched
Power	System: 14-24 VDC, supplied by Omni-Trak 3100 system. Stand-Alone: 18VDC, supplied by HE28A Wall Outlet mounted AC Adapter (120 VAC). For 240 VAC applications use HE28B.
Operational Environment	Operating Temperature Range: 10 to 44° C (50 to 110° F). Storage Temperature Range: -18 to 52° C (0 to 125° F). Humidity: 10 to 90% relative, non-condensing
Physical	Height: 3.25 in. (8.25 cm.) Width: 6.625 in. (16.8 cm.) Depth: 10.25 in. (26.03 cm.) Weight: 5.6 lbs. (2.54 kg.)
RS-232 Modes	Invivo Format (Invivo Research) for communications with Omni-Trak system.

DEFAULT SETTINGS

The Invivo Pulse Oximeter utilizes battery-backed RAM memory to store virtually all settings that the operator can control. This permits an individual's unique monitor settings to always be restored when the unit is turned on. However, as shipped from the factory and whenever the battery is removed or dead, default settings will be chosen by the monitor's processor when turned on.

The default values are as follows:

PARAMETER	DEFAULT VALUE
Pulse Volume	40%
Alarm Volume	50%
Saturation Alarm Limits	High = Off; Low = 85%
Pulse Rate Alarm Limits	High = 160; Low = 45
RS-232	Invivo mode, 9600 baud, 8 bits, no parity, 2 stop bits
Saturation Averaging	6 seconds
Analog Outputs	1 V., Pulse waveform on (PR Sync. off)
Alarms Status	Non-latch

SECTION 1

OPERATION OF THE PULSE OXIMETER

This section provides a brief overview of the Pulse Oximeter, provides information on the controls and indicators of the Pulse Oximeter and provides instructions on the operation of the Pulse Oximeter.

1. OPERATION OF THE PULSE OXIMETER

1.1 Introduction

Noninvasive oximetry for the measurement of arterial blood oxygen saturation was first described by Matthes in 1935. Pulse oximetry provides information about the oxygen status in the blood by using a continuous, noninvasive method of measuring the arterial oxygen levels. A Pulse Oximeter is essentially a multiple-wavelength plethysmograph.

1.1.1 Functional Application. Preoperative SaO_2 monitoring helps to establish a patient's fitness for anesthesia by determining oxygenation levels. This application is particularly valuable to the assessment of patients with respiratory dysfunction. Noninvasive pulse oximetry allows the clinician to follow rapid changes in oxygenation without the physiological trauma of arterial puncture and cannulation. In surgery, mechanical ventilator adjustments (such as changes in inspired oxygen fraction and the use of positive end-expiratory pressure) may be guided by oxygen saturation measurements after an acceptable level of alveolar ventilation is determined from blood gases.

1.1.2 Brief Description of Invivo 4500 MRI Pulse Oximeter. Invivo's 4500 MRI Pulse Oximeter uses a fiberoptic cabling system and remote, shielded photodetector housing with its finger sensor. The Pulse Oximeter is housed in its own $6^1/_2$" x $3^1/_2$" x 10" aluminum case with local LED display of SaO_2 and Pulse Rate. The Pulse Oximeter is mounted in the Magnet room but **must not be placed within 5 feet of magnet's bore**. When in system configuration (3109-1), the oximeter connects to the OMNI-Trak 3100 cabling and power system. The central Omni-Trak MRI unit displays SaO_2, pulse rate, and waveform information. Patient connection is accomplished using a specially designed fiber-optic sensor system mounted in a standard OxiClip finger sensor. When in Stand-Alone configuration the oximeter (3109-3) is powered by a wall outlet transformer.

1.1.3 Theory of Operation. The Invivo 4500 Pulse Oximeter determines the patient's arterial blood oxygen saturation (SaO_2) by measuring the absorption of two selected wavelengths of light. The light generated in the sensor (probe) passes through the blood and tissue and is converted into electronic signals by a photodetector in the sensor.

Blood hemoglobin exists in two principal forms (each of which absorbs light at known wavelengths):

1. HbO_2 (oxygenated, with O_2 molecules loosely bound)
2. Hb (reduced, with no molecules bound)

By passing light from two LEDs (a red wavelength of light at 660 nanometers {RED} and an infrared wavelength of light at 940 nanometers {IR}) through a pulsating arterial site, the difference in absorption characteristics between HbO_2 and Hb (the ratio of oxyhemoglobin to hemoglobin) can be isolated. These variations form the basis of mathematical calculations to determine the presence of hemoglobin carrying oxygen compared to hemoglobin without oxygen (See **Figure 1-1**).

Arterial blood oxygen functional saturation is simply the ratio of oxygenated hemoglobin to total hemoglobin, and can be expressed by the formula:

$$\mathbf{SaO_2 = \frac{HbO_2}{HbO_2 + Hb}}$$

Figure 1-1: Blood Oxygen Saturation Formula

Since HbO_2 and Hb allow different amounts of light at selected wavelengths to reach the photodetector, the electronic signals vary in relation to both the amount of blood present in the tissue (the pulse waveform) and the amount of HbO_2 in the blood.

The oximeter probe passes the two colors of light signals through the tissue very close together, to a photo cell in the probe. The HbO_2 and Hb absorb different amounts of light at selected wavelengths and thereby give rise to the fundamental signal. The photo cell passes the received signal to the oximeter, which filters and amplifies this signal. The signal is then separated by the same timing relationship that drive the LEDs, into two separate voltage channels.

In the monitor, the signals are amplified, and filtered so that artifacts from motion and ambient room light are discarded. The signals which remain are those from the arterial blood. Additional processing allows for the numeric display of SaO_2 and pulse rate on the monitor and the signal quality on the Pulse-Trak™ light bar.

1.1.4 Signal Processing. The IR and RED signals are separated by the time multiplexed analog circuits then passed to the oximeter's microprocessor via A to D converter for processing. Both RED and IR light generate the pulsatile signal, which is then filtered so that artifacts from ambient room light and motion as well as nonpulsating substance are factored out. The remaining RED and IR signals are derived from the arterial blood. The RED pulse amplitude and IR pulse amplitude is then used to calculate SaO_2 The pulsatile change of both is used for artifact rejection and pulse rate calculation.

1.1.4.2 Pulse Strength. The pulse strength signal is designed to give an indication of the percentage change in blood volume, due to the pulse of the patient, regardless of skin pigmentation. The light signal returned to the probe photo cell is modulated by the percentage blood volume in the tissue. When blood rushes into tissue the light received by the photo cell is reduced. As blood drains away, the intensity of light received by the photo cell increases. The difference between the weakest and strongest signals received represent the pulse amplitude. The size of the pulse is directly related to the average strength of the input light. If the average strength of the IR light source were doubled, the strength of the IR pulse would also double. Therefore, if the sensing probe were moved from a pigmented tissue to a non-pigmented tissue, (all other tissue and blood related values staying the same), the strength value would not change. See **Figure 1-2** for the formula for calculating pulse strength.

Pulse Strength is calculated in the following manner:

$$A + K \ln \frac{\text{Strength of IR Pulse}}{\text{Avg. Strength of IR Pulse}}$$

Where A + K are arbitrary scaling constants, set to give pulse gauge a range from 0 to 31.

Figure 1-2: Pulse Strength Formula

1.1.4.3 Reading Variations. The Received Light Signal indicates the amount of light passing through tissue. If the tissue is thin, a great deal of light will pass through the region. The oximeter will indicate this with a high "Light" reading. Conversely, if the tissue is very thick, only a small amount of light will pass through and the "Light" reading will be low. Different areas of the body will give different strength readings. For example, the finger may read 12 or 20, while the ear may read 0 or 3. In general, thin tissue areas show low strength readings because of the large amount of average light that passes through the region compared to the small amount of pulse signal modulation. Low strength values may also indicate unacceptably weak pulse signals. Low levels on thin tissue areas are not as much of a concern as a low reading on thick tissue. The clinician should review the quality of the pulse waveform if there is any question.

1.1.5 Pulse Oximeter Features. The following is a list of features contained in the Invivo Research 4500 MRI Pulse Oximeter:

Exclusive Pulse-Trak™ Light Bar: The most clinically-responsive pulse indicator available. Tracks the pulse waveform so accurately you can actually see the dicortic notch, thereby providing increased confidence in the pulse signal validity.

Audible Pulse Tone: Pulse tone volume is selectable independent from alarm volume. The pulse tone volume is adjustable from 0 to 100% (See Section 3).

Alarms: User adjustable high and low alarm limits for both saturation and pulse rate. Latching/non-latching capability. Battery-backed memory retains your settings, even when power is off.

LED Displays: Easy to read from any angle, in any lighting situation, unlike hard-to-read LCDs.

Battery-Backed Memory: Remembers your monitor settings even when power is off.

Sensor: The Sensor is made up of a fiberoptic cabling system. This exclusive Invivo sensor design makes the 4500 MRI Pulse Oximeter the only available monitor with no imaging interference and no inhibition of SaO_2, pulse rate and pulse waveform during MRI scanning.

Peripheral Gating: The gating output signal from the Omni-Trak is controlled by the Heart Rate source, which is selected from the ECG menu on the Omni-Trak. Select SaO_2 as heart rate source to peripheral gate from the 4500 MRI. When used with the Omni-Trak system, optionally gated signals may be routed to the scanning equipment directly from the Stand Alone or System Ready revisions without the entire Omni-Trak system. In the case of G.E. 5x systems, use the 9xxx or 9xxy OxiGate cable. For other scanners consult Invivo directly.

1.1.6 Fiber Optic Sensor. The sensor is made with a fiberoptic cabling system for relocating the photodetector to a remote shielded housing mounted on the 4500 MRI pulse oximeter. This exclusive Invivo design makes the 4500 MRI Pulse Oximeter the only available monitor with no imaging interference and no inhibition of SaO_2, pulse rate and pulse waveform during MRI scanning.

CAUTION

Glass fiber sensor cable is fragile. The Optic Sensor cable should never be flexed or bent at extreme angles to avoid breaking fiber optic strands within the cable. Use proper care to not pinch or crush the cable. Take extreme care to loop cable neatly for storage, all bends in cable should have larger than a three (3) inch radius.

1.2 Controls and Indicators

REFERENCE FIGURES 1-3 AND 1-4 FOR CONTROL AND INDICATOR LOCATIONS.

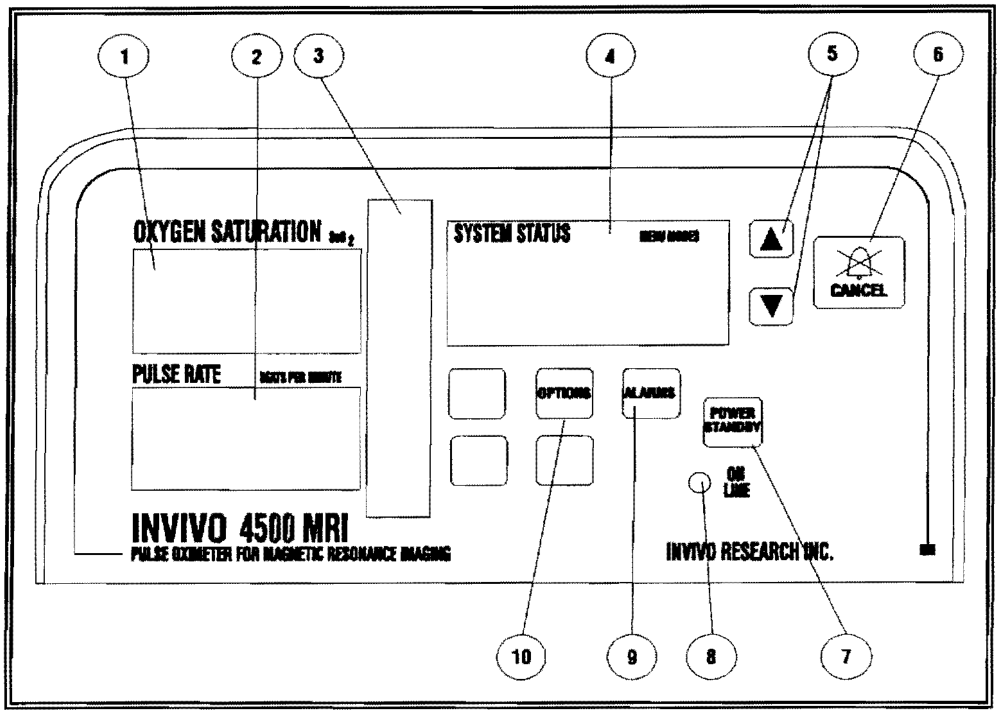


Figure 1-3. 4500 MRI Pulse Oximeter Front Panel

1.2.1 Front Panel. **(See Figure 1-3)**:

Item 1: **OXYGEN SATURATION (SaO_2) Display.** The SaO_2 display indicates the percentage of SaO_2. When the patient sensor is off, or artifact, noise, etc. prevent the monitor from determining the saturation value, three bars (---) are displayed.

Item 2: **PULSE RATE Display.** The PULSE RATE display indicates the detected pulse rate in beats per minute. When the patient sensor is off, or artifact, noise, etc. prevent the monitor from determining the pulse rate, three bars (- - -) are displayed.

Item 3: **Pulse-Trak™ Light Bar.** The height of the Pulse-Trak™ Light Bar varies with pulse and signal strength.

Item 4: **SYSTEM STATUS Display.** The SYSTEM STATUS display indicates a variety of messages and menu selection items.

Item 5: **UP and DOWN Arrows.** The Up and DOWN arrows are used for adjusting selections displayed in the SYSTEM STATUS display.

Item 6: **CANCEL Control.** The CANCEL control silences an alarm tone for 60 seconds, or can be used to inhibit the alarm sound for 60 seconds (see paragraph 1.6: Alarms and Messages). Also returns SYSTEM STATUS display to normal mode when a menu selection has been made.

Item 7: **POWER/STANDBY Control.** The POWER/STANDBY control turns power on. Monitor must be connected to the 3100 MRI monitoring system with 3100 power on, or (in Stand Alone) the HE28A AC Power Adapter must be connected to the I/O port.

Item 8: **RECHARGE Indicator.** The RECHARGE Indicator illuminates when 3100 power is on and monitor is connected to 3100 MRI monitoring system, or (in Stand Alone) when the HE28A AC Power Adapter is connected to the I/O port.

Item 9: **ALARMS Control.** The ALARMS control selects a variety of items from the Alarms menu.

Item 10: **OPTIONS Control.** The OPTIONS control selects a variety of items from the Options menu which are shown in the SYSTEM STATUS display.

1.2.2 Rear Panel. **(See Figure 1-4)**: The 3109-1 4500 MRI back panel contains two I/O ports while the model 3109-3 contains only one. The following is a description of the I/O ports:

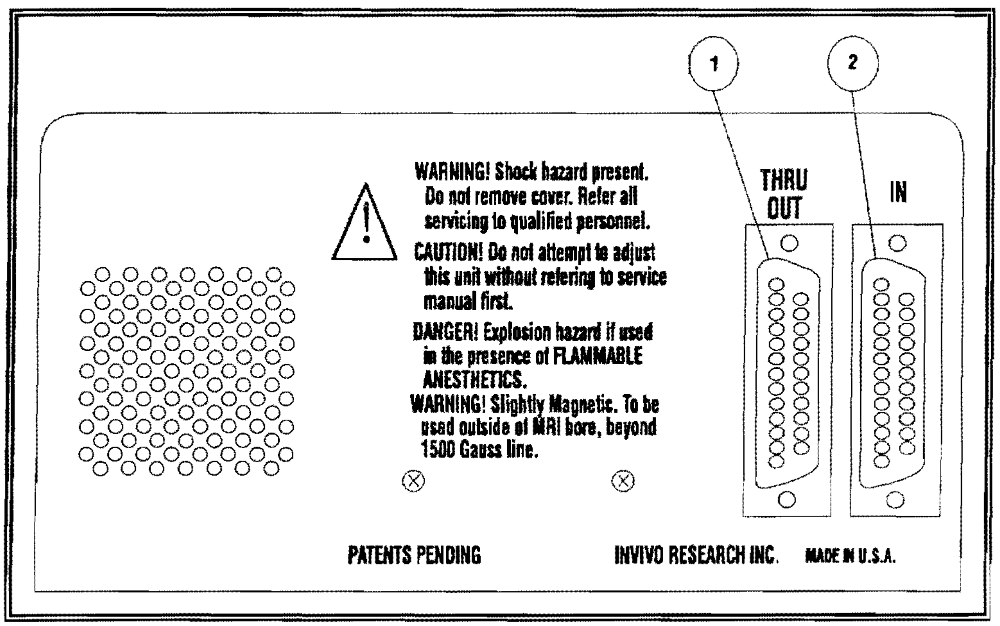


Figure 1-4. 4500 MRI (Model 3109-1) Pulse Oximeter Back Panel

Item 1: **"THRU OUT" I/O PORT.** The "THRU OUT" I/O Port is used to connect the 3103-1 (Omega 1400 MRI NIBP) to the 3100 MRI monitoring system. In normal system installation the 4500 MRI oximeter is mounted on top of the 3103-1 (Omega 1400 MRI NIBP) via the velcro strips attached to the bottom of the 4500

MRI oximeter, then the short (IRI# AC 203) cable connects from the THRU OUT connector of the 4500 MRI to the I/O port of the 1400 MRI NIBP.

Item 2: **"IN" I/O PORT.** The "IN" I/O PORT performs two functions:

a. In system configuration (3109-1), the "IN" I/O Port is used to connect the 4500 MRI oximeter to the 3100 MRI monitoring system via cable from junction box in magnet room.

b. In Stand-Alone configuration (3109-3 {non-system ready}), the I/O Port (which is a DB9 connector rather than a DB25 connector) is used to connect to wall outlet transformer power source. See installation for stand-alone configuration.

NOTE

In stand alone configuration (3109-3) the THRU OUT I/O Port is not used.

1.3 MRI Stand-Alone Pulse Oximeter. The 3109-3 is a Stand-Alone only Pulse Oximeter, equipped with a Rechargable Battery and AC adapter for it's power source. It does not contain the system ready components.

1.4 Using the Monitor

1.4.1 Patient and Probe Preparation. Operation and use of the monitor is easy, if you follow these simple steps.

1.4.1.1 Probe and Site Preparation. Inspect the probe for foreign material such as tape or cotton. Remove any substances which may interfere with the transmission of light between the light source and fiber optic photodetector. Verify that the probe opens and closes smoothly.

NOTE

The probe should be cleaned after each patient use with a cloth, using mild soap and water or isopropyl alcohol. Allow the probe to dry completely before returning to use.

CAUTION

Do not apply undue tension to the probe cable.

Ensure that the patient is not wearing fingernail polish, and does not have artificial or long fingernails. These may cause a reduction in transmitted light levels resulting in low signal levels. Remove fingernail polish before using the finger probe.

WARNING

Do not place the probe on the same limb with a blood pressure cuff. Cuff inflation could result in inaccurate readings and false alarm-violations.

Insert the patient's finger into the probe housing until it touches the raised finger stop inside the probe. Be certain that the surface of the fingertip covers the detector window inside the probe. The fingernail should be UP (i.e., on the same side of the probe as the four-diamond design on the outer surface of the probe).

The patient's finger should remain motionless. Motion can cause artifact and delay the reading or decrease its validity. To additionally secure the probe on the finger, a piece of tape (such as 3M Transpore®) can be wound around the probe. **DO NOT CUT OFF THE CIRCULATION!**

1.4.1.2 Probe Positioning. Position the probe according to the instructions that follow. Check monitoring site, reposition probe, and check ambient environment when the following messages appear.

a. Check that the monitoring site is good and the probe properly positioned by verifying a strong pulse signal from the Pulse-Trak Light Bar and/or the real-time pulse waveforms.

b. The pulse bar on the 4500 MRI or the pulse waveform on the Omni-Trak screen should be used as an indication of interference. Normal (noise free) signals will cause a smooth rhythmic pulse bar or waveform pattern. Excessive noise can cause erroneous readings.

1.4.1.3 Probe Removal. If the sensor probe is removed from the patient or dislodges, Probe Off will be shown in the SYSTEM STATUS display, and the alarm tone will sound. The alarm tone can be silenced by pressing the CANCEL control.

1.4.1.4 Infant Extremities. The preferred site for monitoring neonates and infants is the foot. However, the sensor may be applied on the hand or toe. The sensor can be applied at right angles to these small appendages, use caution to support the mass of the fiber optic cable so that it doesn't pull the sensor away from the monitoring site. When placing the sensor on the fingers or toes, verify that the optical center of the sensor (light) directly illuminates the appendage and doesn't shine between them.

WARNING

As with all items placed in the bore, assure that cable runs straight out the bore and at least 4 inches from any other cable. The patient's finger or toe should not pin the sensor close to the side of the bore. Be sure to inspect all equipment for damage.

CAUTION

Glass fiber sensor cable is fragile. The Optic Sensor cable should never be flexed or bent at extreme angles to avoid breaking fiber optic strands within the cable. Use proper care to not pinch or step on cable. Take extreme care to loop cable neatly for storage, all bends in cable should have larger than a three (3) inch radius. Do not attempt to disconnect cable from unit. Refer all servicing to qualified personnel.

1.4.2 Operating the Monitor. To operate the monitor, perform the following steps:

a. Depress the POWER/STANDBY control.

b. Observe the following:

(1) The SYSTEM STATUS display indicates "Hello."

(2) All other front panel displays are illuminated (verifying the operation of the display system).

(3) A short, soft tone sounds (verifying operation of the audio alarm system).

(4) The SYSTEM STATUS display indicates the current alarm values in the following sequence:

(a) HiSa = xxx (High Saturation Alarm Limit)
(b) LoSa = xxx (Low Saturation Alarm Limit)
(c) HiPR = xxx (High Pulse Rate Alarm Limit)
(d) LoPR = xxx (Low Pulse Rate Alarm Limit)

(5) The alarm will sound briefly to call special attention to any limit previously set to "off". Thanks to the oximeter's battery-backed memory, most settings of the monitor will remain just as they were left from the previous use. **EXCEPTIONS: As a safety feature, if the LoSa alarm limit has been set to Off, it will be reset to 85%; and if the Alarm tone volume has been set to Off, it will be reset to 50%.**

(6) If any front-panel control key is pressed, the monitor will stop the Alarm review and the corresponding menu will shown in the SYSTEM STATUS display.

1.4.2.1 Connected Probe. If the probe is on the patient, the Pulse-Trak™ light bar will begin to track the pulse while the alarm limits are being displayed. After four to six pulses, the oxygen saturation value (percent of saturation) and pulse rate (beats per minute) will appear in their displays. The time of day will be shown in the SYSTEM STATUS display.

1.4.2.2 Unconnected Probe. If the probe is not connected to the patient, ProbeOff will appear in the SYSTEM STATUS display.

1.4.3 Setting Other Parameters. If desired, alarm limits and filter mode may be set, as described in the following sections.

1.5 System Operation Review

1.5.1 Input Power. Input power depends on whether the Pulse Oximeter is in System (3109-1) or Stand-Alone (3109-3 {non-system ready}) Configuration.

1.5.1.1 System Configuration. When in system configuration (3109-1), the oximeter connects to the OMNI-Trak 3100 cabling and power system.

1.5.1.2 Stand-Alone (3109-3: Non-System Ready) Configuration. When in Stand-Alone (3109-3: Non-System Ready) Configuration, the oximeter is powered by an internal Rechargable Battery (approximately two hours) or by a wall outlet transformer.

1.5.2 Status Display and Control. Through processor and front panel display board interaction of control switches and status display the system responds to operator requests as well as display of SaO_2, Pulse rate, and pulse bar.

1.5.3 SaO_2 Filter. The displayed saturation value may be selected for either 3, 6, or 12 seconds of data averaging.

1.5.4 Pulse Output. The Pulse output from the analog board may be set for either pulse waveform (system configutation) or sync pulse output. Through Option switch front panel selection this output may be set for 1, 3, 5, or 10 volt full scale (normally 3V for system configuration).

1.5.6 Software Revision. The software revision is displayed in the status display when selected from the front panel option switch (last menu selection on the option switch).

1.5.7 Cold Start. The 4500 Pulse Oximeter utilizes battery backed up RAM memory to store practically all possible settings that the operator can control. This permits an individual's unique monitor settings to always be restored when the unit is turned on. However, whenever the battery is removed or dead, or a cold start is initiated, default settings will be chosen by the 4500 processor when turned on.

1.5.7.1 Cold Start Initiation. To initiate a cold start from the front panel switches, hold the upper left blank feed and cancel switches depressed during power up. Cold Start default settings are as follows:

Pulse Volume	40%
Alarm Volume	50%
High Sat Limit	Off
Low Sat Limit	85
High Pulse Rate	160
Low Pulse Rate	45
RS-232	Invivo, 9600 Baud, 7 bit, even, 1 stop
Filter Mode	6
Analog Out	1 V (Pulse waveform on/SYNC)
Time and Date	(Current year of last revision) Jan 1, 00:00:00
Latch/No Latch	No latch (Alarm status)

1.6 Alarms and Messages

The Invivo 4500 MRI Pulse Oximeter provides high and low alarm limits for both saturation and pulse rate. The battery-backed memory insures that most of the alarm values you set are retained, even when power is off.

1.6.1 General Operation of Menus.

The Oximeter's two menus (Alarms and Options) are accessed by pressing the appropriate control key on the front panel. The first item of the menu is then shown in the SYSTEM STATUS display.

As a safety feature, all menus automatically time-out, and the monitor returns to normal operation, if no controls are pressed within 60 seconds. To exit a menu at any time, simply press the CANCEL control.

1.6.2 Setting the Alarms. To set the Alarms, select the paragraph (below) which corresponds to the Alarm you wish to set.

1.6.2.1 HiSa Alarm. Perform the following to change the HiSa Alarm limit:

a. Press the ALARMS control.

b. Observe the following:

(1) SYSTEM STATUS display indicates the current High Alarm Limit for saturation.

c. To increase the HiSa Alarm Limit perform step (1); to decrease the HiSa Alarm Limit perform step (2):

(1) Press the UP Arrow.

(a) Pressing and releasing the UP Arrow will increase the Alarm Limit by the value of one.

(b) Pressing and holding the UP Arrow will increase the Alarm Limit rapidly.

(c) When the value reaches its upper limit, the display will show **OFF**, indicating the HiSa Alarm is off. It will then "roll over" to its lowest value and repeat the process.

(2) Press the DOWN Arrow.

(a) Pressing and releasing the DOWN Arrow will decrease the Alarm Limit by the value of one.

(b) Pressing and holding the DOWN Arrow will decrease the Alarm Limit rapidly.

(c) When the value reaches its lower limit, the display will show **OFF**, indicating the HiSa Alarm is off. It will then "roll over" to its highest value and repeat the process.

1.6.2.2 LoSa Alarm. Perform the following to change the LoSa Alarm limit:

a. Press the ALARMS control two times.

b. Observe the following:

(1) SYSTEM STATUS display indicates the current Low Alarm Limit for saturation.

c. To increase the LoSa Alarm Limit perform step (1); to decrease the LoSa Alarm Limit perform step (2):

(1) Press the UP Arrow.

(a) Pressing and releasing the UP Arrow will increase the Alarm Limit by the value of one.

(b) Pressing and holding the UP Arrow will increase the Alarm Limit rapidly.

(c) When the value reaches its upper limit, the display will show **OFF**, indicating the LoSa Alarm is off. It will then "roll over" to its lowest value and repeat the process.

(2) Press the DOWN Arrow.

(a) Pressing and releasing the DOWN Arrow will decrease the Alarm Limit by the value of one.

(b) Pressing and holding the DOWN Arrow will Decrease the Alarm Limit rapidly.

(c) When the value reaches its lower limit, the display will show **OFF**, indicating the LoSa Alarm is off. It will then "roll over" to its highest value and repeat the process.

NOTE

As a safety feature, if LoSa is set to Off, it will be reset to 85% if the monitor is turned off and then turned on again; otherwise, it is not affected.

1.6.2.3 High Pulse Rate Alarm. Perform the following to change the High Pulse Rate Alarm limit:

a. Press the ALARMS control three times.

b. Observe the following:

(1) SYSTEM STATUS display indicates the current High Alarm Limit for saturation.

c. To increase the High Pulse Rate Alarm Limit perform step (1); to decrease the High Pulse Rate Alarm Limit perform step (2):

(1) Press the UP Arrow.

(a) Pressing and releasing the UP Arrow will increase the Alarm Limit by the value of one.

(b) Pressing and holding the UP Arrow will increase the Alarm Limit rapidly.

(c) When the value reaches its upper limit, the display will show **OFF**, indicating the High Pulse Rate Alarm is off. It will then "roll over" to its lowest value and repeat the process.

(2) Press the DOWN Arrow.

(a) Pressing and releasing the DOWN Arrow will decrease the Alarm Limit by the value of one.

(b) Pressing and holding the DOWN Arrow will Decrease the Alarm Limit rapidly.

(c) When the value reaches its lower limit, the display will show **OFF**, indicating the High Pulse Rate Alarm is off. It will then "roll over" to its highest value and repeat the process.

<u>1.6.2.4 Low Pulse Rate Alarm.</u> Perform the following to change the Low Pulse Rate Alarm limit:

a. Press the ALARMS control four times.

b. Observe the following:

(1) SYSTEM STATUS display indicates the current Low Alarm Limit for saturation.

c. To increase the Low Pulse Rate Alarm Limit perform step (1); to decrease the Low Pulse Rate Alarm Limit perform step (2):

(1) Press the UP Arrow.

(a) Pressing and releasing the UP Arrow will increase the Alarm Limit by the value of one.

(b) Pressing and holding the UP Arrow will increase the Alarm Limit rapidly.

(c) When the value reaches its upper limit, the display will show **OFF**, indicating the Low Pulse Rate Alarm is off. It will then "roll over" to its lowest value and repeat the process.

(2) Press the DOWN Arrow.

(a) Pressing and releasing the DOWN Arrow will decrease the Alarm Limit by the value of one.

(b) Pressing and holding the DOWN Arrow will Decrease the Alarm Limit rapidly.

(c) When the value reaches its lower limit, the display will show **OFF**, indicating the Low Pulse Rate Alarm is off. It will then "roll over" to its highest value and repeat the process.

<u>1.6.2.5 Alarm Limits Range.</u>

High Saturation: 70 to 100%
Low Saturation: 50 to 100%
High Pulse Rate: 70 to 250 bpm
Low Pulse Rate: 20 to 200 bpm

1.6.3 Latching or Non-Latching Alarm Modes. To display the Alarm Mode, press the ALARMS control five times and the Alarms display will indicate the status (latching or non-latching) of the Alarm Mode.

1.6.3.1 Latching Mode. In the Latching Mode, when an active Alarm is violated, the Alarm tone will continue to sound even if the parameter goes back within the Alarm Limit until CANCEL is pressed.

1.6.3.2 Non-Latching Mode. In the Non-Latching mode, when an active Alarm is violated, the alarm tone will sound only as long as the Alarm Limit is exceeded. If the value goes back within the alarm limit, the alarm tone will cease. The alarm tone may be silenced at any time with the CANCEL control.

1.6.3.3 Changing the Alarm Mode. The UP and DOWN Arrows toggle the Alarm Mode between Latching and Non-Latching.

Note

The pulse tone volume may be accessed quickly from the front panel. If no menu is currently active, pressing either arrow key will activate the pulse volume setting directly.

1.6.4 Pulse Tone Volume. To display the Pulse Tone Volume, press the ALARMS control six times and the Alarms display will indicate the Pulse Volume setting (**pVol=xx%**).

1.6.4.1 Pulse Tone Operation. When the monitor is connected to a patient, a short tone will sound with each detected pulse. The volume of this tone may be adjusted from 0 to 100% using the arrow keys. When the setting reaches its upper or lower limits, it will show **OFF**.

NOTE

As a safety feature, if the Alarm volume is set to OFF, and the monitor is turned off and back on again, the volume will be automatically reset to 50%.

1.6.5 Alarm Tone Volume. To display the Alarm Tone Volume, press the ALARMS control seven times: the Alarms display will indicate the Alarm Tone setting and the Alarm tone will begin to sound.

1.6.5.1 Alarm Tone Adjustment. Use the UP or DOWN Arrow keys to adjust or turn off the alarm tone. When the setting reaches its upper or lower limits, it will show **OFF**. When the Alarm tone

is turned off, violation of an alarm is indicated by a flashing display of the violated parameter. The SYSTEM STATUS display will also indicate the reason for the alarm.

1.6.6 CANCEL Control. Depress the CANCEL Control to silence an alarm tone when it is sounding. The alarm tone will be suspended for 60 seconds, regardless of interim violations.

1.6.6.1 Other Uses. The CANCEL control can also be used to prevent alarm violations for a 60-second period. For example, if you will be removing or adjusting the probe, press CANCEL as many times as needed. Pressing CANCEL when there is no Alarm Tone (violation) current will suspend Alarm occurance for 60 seconds.

1.6.7 Alarm & Warning Messages. There are several types of alarm/warning messages produced by the Invivo 4500 MRI Pulse Oximeter. When one of the following conditions occur, the message is shown in the SYSTEM STATUS display.

1.6.7.1 Initialization Messages. These messages appear when the monitor is first powered up.

RAM Bad: System service required.

ROM Bad: System service required.

A/D-Bad: System service required.

Ram Lost: Auto reset to defaults.

Sys Init: System initialized to default settings.

1.6.7.2 Problem Messages. The following list of messages will be displayed if the corresponding condition is detected. These messages take precedence over Alarm Violation messages:

Batt Low: Battery is low. If this message appears on the 3109-1, the power supplied by the 3100 is too low and service to the 3100 MRI system may be required. Also, facility main power could be low.

If this message appears on the 3109-3, the internal battery requires recharging. Recharge by plugging the wall outlet transformer into rear connector and into an AC receptacle of the correct voltage.

Bad Probe: Probe is not functioning properly.

Can't 0: There is a strong flashing light near the probe which is synchronized with the probe LED strobe signal, or a hardware failure has occurred.

Noise: The photo sensor is receiving extraneous optical or electrical noise.

Low Light: Light transmission impeded, tissue too opaque.

Probe Off: Sensor not viewing patient.

Probe OFF: The sensor is receiving too much light to operate.

HiLight: Too much light is passing through the tissue at the present probe sight. Try an area with thicker tissue.

HiLight!: The multi-site sensor is receiving too much light for proper operation.

Search: Searching for good pulse.

Artifact: Excessive artifact in signal.

LowQual: The signal correlation between the red and infra-red light channels is too low for accurate saturation calculation.

1.6.7.3 Alarm Violation Messages. If none of the above conditions exist, and if one or more of the four alarm limits are violated then the SYSTEM STATUS display will indicate the alarm violation.

If one limit is violated, its message will be displayed continuously. If several alarm limits are simultaneously violated, each alarm violation will be displayed, one per second, on a rotating basis.

AlrmHiSa High saturation alarm limit exceeded.

AlrmLoSa Low saturation alarm limit exceeded.

AlrmHiPR High pulse rate alarm limit exceeded.

AlrmLoPR Low pulse rate alarm limit exceeded.

If no alarm limits are violated or no "Problem" messages are displayed, the following informational messages will alternate with the Time in the SYSTEM STATUS display if one of these conditions exists:

Alarm Off: Either the alarm-tone volume is set to Off, or ***all four*** alarm limits are set to Off.

LoSatOff: Low saturation alarm limit is set to Off.

1.7 Options Menus

The Options Menus are used to set the Filter Mode for saturation, Set the real-time clock and to check the software revision number.

1.7.1 General Operation of Menus. The Pulse Oximeter's two menus (Alarms and Options) are accessed by pressing the appropriate control key on the front panel. The first item of the menu is then shown in the SYSTEM STATUS display. As a safety feature, all menus automatically time-out (the monitor returns to normal operation) if no key is pressed within 60 seconds. To exit a menu at any time, simply press the CANCEL key.

1.7.2 Saturation Averaging. The monitor may be set to average the Saturation value over 3, 6, or 12 seconds. The faster setting allows you to track rapidly-changing saturation values. The slower setting allows for a more-stable display of saturation values, and may be indicated for long-term monitoring where patient artifact is great. The saturation averaging time does not affect the Pulse reading or Pulse-Trak light bar.

1.7.2.1 Setting the Saturation Average. Perform the following to set the Saturation Averaging Time:

a. Press the OPTIONS control once.

b. Observe that the SYSTEM STATUS display indicates **Fil=xxsc**.

c. Use the UP or DOWN Arrow keys to set the averaging time to 3, 6 or 12 seconds.

1.7.3 Interface Options. Two other selections on the OPTIONS menu, **Analog** and **RS-232** are used for setting the way in which the pulse oximeter interfaces with external devices such as other patient monitors. Details on setting these options are contained in Appendix B.

1.7.4 Checking the Software Revision Number. When calling Invivo Customer Service or Technical Service (toll free: (800) 331 - 3220) for assistance with a problem with your oximeter, it is helpful to know the serial number of your monitor (found on the bottom of the monitor), and the software revision number.

To obtain the software revision number, press the OPTIONS control seven times. The SYSTEM STATUS display will show **Rev.MXXX**, where XX is the revision number.

Appendix C contains a current listing of software revisions.

SECTION II

THEORY OF OPERATION

This section describes the operation of Invivo Research Model 4500 MRI Pulse Oximeter.

2. THEORY OF OPERATION

2.1 Introduction

Pulse oximetry is the continuous, noninvasive method of measuring arterial oxygen levels in the blood. It provides information about oxygen status. Noninvasive oximetry for the measurement of arterial blood oxygen saturation was first described by Matthes in 1935. A Pulse Oximeter is essentially a multiple-wavelength plethysmograph.

For a complete discussion on the theory of Pulse Oximetry, refer to paragraph 1.1.3.

2.2 AB17A Display Board

REFERENCE DRAWING 85D107 (APPENDIX A, PAGE A-9)

The Display Board provides operator interaction with the patient monitor.

The Display Board consists of 1 power and 8 function switches; 6 numerical LEDs and 2 bar LEDs; and an intelligent 8 character display assembly. It provides patient parameter information, system status messages and an interface between the operator and the oximeter system. Function switches SW1 through SW7 and SW9 form a switch matrix which is controlled and periodically monitored by the Processor Board to determine if the system operator wants the oximeter to perform a designated task. Low logic levels are applied to P1 (pins 41, 42, 43 and 46) and routed to four switch pairs as designated in the display schematic. R1 and R2 form a pair of pull-up resistors on the normally open contacts of two groups of four switches as shown. When the operator depresses a switch the corresponding output will go low at P1 pin 44 or P1 pin 45 and the processor will decode the input to determine what action has been requested.

System power switch SW8 receives unregulated system power from P1 pin 48. When SW8 is depressed the unregulated system power will be routed to the Power Supply Board via P1 pin 50.

Numerical LEDs DS1-DS6 are used to display patient parameters during system operation. Individual LED segments are turned on or off by the combination of the drive levels applied at the LED segment anodes by DIGIT1-DIGIT6 signals from P1 (pins 1 through 5) and the drive levels applied at the LED segment cathodes by the a-f and dp signals applied at P1 pins 9-16. The Processor Board controls the signal combinations to display intelligent information. Bar LEDs DS7 and DS8 are controlled in the same manner and represent a visual, real time display of the patient pulse waveform as measured by the oximeter system.

DS9 is an intelligent 8 character generator used to display system status information to the oximeter system operator. It is interfaced directly to the microprocessor bus on the processor assembly as shown. Messages are written to DS9 to inform the operator of system status during operation, the configuration of software features (Options and Alarms), display prompts required for operator interaction with the oximeter, and provide the operator with the current time. R4 and DS10 is connected between the power supply unregulated DC bridge voltage and ground. LED DS10 provides a visual indication to the operator when the oximeter is connected to an external power source.

2.3 AB17B Processor Board

REFERENCE DRAWING 85D154 (APPENDIX A, PAGE A-12)

The Processor Board contains the hardware necessary to control the oximeter system operation; perform timing and measurement operations; provide data memory storage; and interface with the display and RS232 ports. Hardware control features consists of the reset circuits, power supply shutdown circuit, and clock circuit. Hardware pertaining to other system functions will be included in the description of the circuit itself.

The power up reset command is generated by a RC network consisting of C38 and R10 and inverter U15 (pins 3 and 4). As the +12vdc supply rises when the power supply is turned on, C38 will be charged toward a +12 VDC potential at the input of U15 pin 3. The amplitude of charge will be limited to approximately +5 VDC by the rate of change of the charge and the input protection diodes located within U15. The +5 VDC supply to U15 will rise at the same rate as the +12 VDC supply so U15 will be fully operational when the positive going pulse is received. The positive pulse will decay at a rate equal to the RC time constant of C38 and R10 when the +12 VDC supply stops rising. U15 will invert this pulse and apply it as a negative going reset pulse to microprocessor U4 pin 26, I/O ports U20 pin 1, U21 pin 1, U23 pin 1 and U24 pin 1, reset generator input U15 pin 5, and to the analog and display assemblies via J3 pin 22 and J2 pin 17. U15 pin 6 provides the positive going reset pulse for the UART U3 pin 21. This initializes the UART and prepares it for setup instructions. The function of the reset pulses is to prepare the IC's receiving them for operation and to allow the clock circuits time to stabilize. During the power down sequence the power supply assembly provides a positive pulse named memory shutdown to J1 pin 14 which is routed to U15 pin 3 and causes a reset pulse to be generated.

During the power up sequence a rising positive voltage pulse will charge the RC network of C37 and R9 to produce a high on the input of U15 pin 9. The amplitude and duration of this pulse will be large enough and long enough to cause a negative going pulse with a minimum duration of 100 ms to be output at U15 pin 8. This allows the power supply to operate by itself for a short period of time while the reset pulses occur and the microprocessor begins to operate. When the microprocessor receives a power off signal (or in the event of a malfunction) the microprocessor stops sending pulses from U24 pin 2 to J1 pin 7 printer power control. The printer power voltage at J4 pin 1 and C35 will discharge through R11 to 0 VDC. The high logic voltage at U15 pin 9 and C37 will discharge through R9 towards 0 VDC and U15 pin 8 will send a positive pulse through P3 to J1 pin 6 to shutdown the power supply assembly.

2.3.1 Clock Circuit. The clock circuit consists of two inverter sections with negative feedback resistors, two timing capacitors, a series connected crystal oscillator, coupling capacitor, one D flop and two inverter drivers. The clock provides a stable 4 MHz frequency source for microprocessor and counter-timer operations.

2.3.1.1 Clock Circuit Function. R1 connects the output of U12 pin 2 back to its input at U12 pin 1 so the inverter will be biased in a linear manner halfway between its high and low logic states in a static condition. C28 is connected between the input of U12 pin 1 and ground while C29 is connected between the output of U12 pin 2 and ground. Y1 is connected between U12 pin 1 and U12 pin 2 and acts as an LC network resonant at 8MHz. When power is applied C28 pulls the input of U12 pin 1 low. The output will go to a high level and feed back to the input through the network made up of C29, Y1 and C28 causing the input to go high and drive the output low. The low output will feedback to the input through C29, Y1 and C28 causing it to go low again and the process will repeat at the 8 MHz resonant frequency of Y1.

The output of U12 pin 2 is coupled through C30 to the input of U12 pin 3 which has also been biased in a linear manner with the input at U12 pin 3 connected to the output at U12 pin 4 by R2. U12 pin 4 will invert the input and clock one half of D flop U2 pin 3 which is connected in a divide by two configuration. U2 pin 5 will provide a square wave 4 MHz output which is connected to a pair of inverter drivers at U12 pin 5 and U12 pin 9. The outputs of U12 pin 6 and U12 pin 8 are tied together to increase the drive current of the clock. The clock is sent to U8 (pins 9, 15 and 18), U9 (pins 9, 15 and 18), U10 (pins 9, 15 and 18), U4 pin 6 and U3 pin 20.

IC's U8, U9 and U10 are identical 3 section counter timers which perform the timing and measurement functions of the oximeter under the control of the microprocessor. U8 performs the Stat, Red channel and IR channel measurements from the analog assembly in the following manner. At the start of the 60.05 Hz sample/reset period the gates to U8 (pins 11, 14 and 16) are inhibited by a low logic level pulse from U13 pin 6 to U16 (pins 2, 5 and 9). The microprocessor reads the current values stored in U8's counters and restarts them at FFFF (hex).

The 60.05 Hz sample/reset pulse resets the comparators on the analog assembly and the Stat, Red and IR inputs at J3 (pins 19, 20 and 21) are pulled to a high logic level by R3, R4 and R5 and at U16 (pins 1, 4 and 10). The pulse from U13 pin 6 to U16 (pins 2, 5 and 9) is then set to a high level at the end of the 60.05 Hz sample/reset period resulting in high logic levels at U16 (pins 3, 6 and 8) which enable the counters at U8 (pins 11, 14 and 16).

The counters inside U8 will begin counting at a 4 MHz rate. When one of comparators on the analog assembly sets, the corresponding logic level at the input of U16 will go low inhibiting the counter in U8. The count value will then be read by the microprocessor at the start of the next 60.05 Hz sample/reset period.

U9 is used as a timer. U9 pin 17 is connected to UART U3 (pins 9 and 25) to control the baud rate. U9 pin 10 is routed to J3 pin 23 as the P.S. Clock signal which gates the timing and control circuits in the analog assembly. U9 pin 13 enables G1 and G2 of U10 (pins 14 and 16). The corresponding outputs of U10 (pins 13 and 17) are used to pulse width modulate the IR and Red drive signals at J3 (pins 24 and 25). U9 pin 13 also provides a clock signal to U13 (pins 3 and 11) to generate the starting time of the 60.05 Hz sample/reset pulse; disable the gates of counter U8; and generate a

microprocessor interrupt. U10 pin 10 is routed to U16 pin 12 where it is used to generate a nonmaskable interrupt to microprocessor U4.

The microprocessor maskable interrupt U6 pin 16 is driven by a 4 input NOR U14 pin 13. The main timing clock U9 pin 13 toggles U13 pin 9 driving U14 pin 11 which generates a processor interrupt. The software will clear this flip-flop and set the appropriate logic level on U13 pin 2 to prepare for the next clock from U9 pin 13. The processor uses the 540 Hz clock from U9 pin 13 and U13 pin 9 to generate the 60.05 Hz pulses.

There are three other interrupt sources. The UART Tx Ready U3 pin 15 and Rx Ready U3 pin 14 are used during RS232 communication. During every maskable interrupt the processor checks the UART to see if service is required. The final interrupt source is J1 pin 12 (the low power interrupt).

NOTE

This signal requests the system to immediately shut down. The microprocessor shutdown defeat switch (P3) enables a technician to keep the power supply running if required for test purposes by forcing a low logic level at J1-6.

Memory storage for the oximeter programs and data is provided by a 32k by 8 bit ROM U5 and 32k by 8 bit static RAM U7. RAM or ROM selection is enabled by U14 (pins 2, 3, 4 and 5) and U15 (pins 1 and 2) for the ROM and U17 for the RAM. Microprocessor MReq and A15 outputs control RAM or ROM selection. Battery or +5 VDC power is applied to RAM U7 and decoder U17 at all times by the oximeter battery via J1 pin 1 or +5 VDC via D1. This enables data storage when the system is powered down.

Battery power is also routed to J3 pin 1 for use by the analog assembly clock. During a power up or power down sequence the reset signal applied to U4 pin 26 and U17 pin 6 disables memory selection to prevent erroneous data from being input to the RAM. R7 inhibits RAM selection during power off periods.

The microprocessor interfaces to the display, printer (non MRI) and RS232 ports through the data bus and I/O ports. I/O port selection is performed by decoders U18 and U19. I/O ports U20, U21, U23 and U24 are used write data to system devices. I/O port U22 is used to read data from system inputs.

U11 is a LSI IC used to control discrete LED segments on the Display Board. Data for display is written into U11 when the write line is set to a logic low between U19 pin 15 and U11 pin 8. U24 pin 5 is set high or low to determine the display mode of U11. The output lines of U11 are routed directly to LED segments on the Display Board to turn them on or off.

The data bus, address lines (A0, A1, A2, A8, A9 and A10) and RD, WR signals are routed to the Display Board to interface with the intelligent 8 character system status display.

The 8 function switches on the Display Board are interfaced by writing logic levels from U23 (pins 12, 15, 16 and 19) to the switches via J2 (pins 41-43 and 46) and reading the results from J2 (pins 44 and 45) to U22 (pins 2 and 4) to determine switch status. The power switch and recharge LED signals are routed from power supply connector J1 directly to Display Board connector J2. +5 VDC system power is routed to the Display Board via J2 (pins 35 and 36).

UART U3 is selected by writing a low logic level from U18 pin 14 to U3 pin 11 and reading or writing to the chip via the data bus. The UART is configured by the operator during system operation if desired. The UART uses the multilevel interrupt to tell the microprocessor when it is ready to transmit data (U3 pin 15 to U14 pin 10 goes high) or the receive buffer is full (U3 pin 14 goes high). The UART is interfaced to RS232 port P1 by RS232 driver U1 and pull-up resistors R13 and R14. U1 is configured to allow the RS232 port to operate in the full duplex mode if desired.

Microprocessor data bus and control signals are also sent to the analog assembly. The functions they perform are described in the analog assembly theory of operation. The overload signal input from J3 pin 30 to U22 pin 17 is used to monitor the status of the analog assembly receiver circuit. R16 and C42 insure a low logic level pulse will remain present long enough to be read by the microprocessor. The remaining components on the Processor Board are power supply filter capacitors.

2.4 AB17C1 Analog Board

REFERENCE DRAWING 185D155 (APPENDIX A, PAGE A-15)

The Analog Board provides patient input parameter measurement, timekeeping, digital to analog signal conversion and audio alarm power. The Analog Board may be divided into two main areas: the isolated section and the non-isolated section.

2.4.1 Isolated Section. The isolated section consists of four functional circuit elements: timing and control, LED drive, the receiver- amplifier, and ramp comparator circuits. The timing and control circuits perform system timing functions that maintain sychronization between the LED drive, signal comparators and receiver demodulator circuits.

The system clock is input as a 51.29 KHz negative going rectangular pulse train from J3-23 to optocoupler U15 pin 3. Current between U15 pin 3 and U15 pin 4 is limited to 5 ma by R30. The clock signal is passed through the optocoupler and output at U15 pin 6 to drive U31 pin 1 and pull-up resistor R37. The clock output at U31 pin 2 is applied to the clock inputs of the 12 stage counter U33 and the octal data flip-flop U22. U33 pin 9 outputs a 12.822 KHz square wave clock to U31 pin 13 which is inverted and output at U31 pin 12. This signal is differentiated by the C92, R75 combination and applied to the inhibit line of U20 (this net-work prevents glitches on the LED transmitters during high level signal switching). U33 pin 7 is a 6.411 KHz square wave which is inverted by U31 (pin 11 to pin 10) and applied to the clock 1 input of U27 and the channel A (LSB) bit of 8 channel analog multiplexer U20. U33 pin 3 is a 1603 Hz square wave applied to U22 pin

3 and the channel B input of U20 pin 10. U33 (pins 2 and 4), and U32 (pins 1, 2 and 3) form a counter reset which resets U33 pin 11 every 96 clock pulses.

The reset circuit also clears section 2 of dual counter U21 pin 14 and is inverted by U31 (pins 3 and 4) before being applied to U32 pin 9 as part of U21 section 1's counter reset circuit. Section 1 of dual counter U21 divides the 12.822 KHz clock signal input at pin 4 by three by anding the outputs of pin 5 and 6 and routing the result to pin 2. U32 (pins 4, 5 and 6) perform the AND function. U31 pin 6 inverts the signal and applies it to U32 pin 10 where it is combined with the divide by 96 reset at U32 pin 9 and routed from U32 pin 8 to U31 pin 9 for reinversion before being applied to the reset at U21 pin 2. By combining (logic OR) the divide by 96 reset and divide by 3 (12 clocks), synchronous timing is maintained between counters U21 and U33. The output of U21 pin 6 is a rectangular positive-going pulse recurring at a 4.274 KHz rate and is applied to the clock input of U21 pin 15 (section 2) where it is divided by 2 and output as a 2.137 KHz square wave at U21 pin 13.

The 2.137 KHz square wave is routed to U20 pin 9 (Channel C,MSB) of the 8 channel multiplexer and U22 pin 18. U22 is used to route the 2.137 and 1.603 KHz signals to U23 pin 15 (2.137 KHz IR) and U23 pin 10 (1.603 KHz Red) to demodulate the receiver outputs for processing by the signal low pass filters.

A system time input (50\60 Hz) is input at J3-26 where it is current limited by R29 to approximately 17 ma and applied to opto-coupler U15 pin 1. The output is inverted by U15 at pin 7 and drives pull-up resistor R41 and U32 pin 12. U32 pin 13 is tied to a logic high level so the output at U32 pin 11 is in phase with the input at pin 12 and is applied to U19 (pins 1, 8, 9 and 16) to synchronize the ramp reset with the comparator sample and hold functions. The pulse period of the 50\60hz sample pulse is 60.05 Hz. The system inputs at J3 pin 27 (48H Q0) and J3 pin 28 (48H Q1) are current limited by R27 and R28 to 5 ma and applied to optocoupler U14 (pins 2 and 3) for coupling across the isolation barrier. The noninverted outputs of U14 are routed from pins 7 and 6 respectively to two address lines (A0: pin 1 and A1: pin 16) of an 8 channel analog multiplexer U18. R38 and R39 are pull-up resistors required for proper operation of the open collector optocoupler outputs. System input signals 48H Q0 and 48H Q1 are used to sample the +10.0 VDC reference, analog ground reference, patient input probe connection and P.S. Test signals during system operation.

LED Drive Section: The LED drive section contains two drive level integrators, a drive signal multiplexer and a differential drive amplifier to control the intensity of the RED and IR LEDs contained in the patient finger probe.

a. The RED drive signal is a negative going rectangular pulse train with a period of 540 Hz and a duty cycle corresponding to the desired RED LED intensity. The pulse period is phase locked with the LED drive, receiver demodulator, and comparator sampling signals to minimize transmitter modulation (noise) of the received signals. The RED drive signal is current limited to 7 ma by R26 and applied to optocoupler U13 pin 2. The output is an in phase signal taken at U13 pin 8 and applied to load resistor R34. The voltage at R34 is integrated by the RC combination of R33 and C34 into a positive DC level corresponding to the duty cycle of the applied pulse

train. This DC level is routed to an 8 channel analog multiplexer U20 (pins 4 and 12) for switching into the differential transmitter amplifier.

b. The IR drive functions in an identical manner, applying a pulse width regulated, negative going, rectangular pulse to U13 pin 3 through current limiting resistor R25. The output as taken from U13 pin 6 and across R35 is a negative pulse as is the integrated voltage level at the junction of integrator components R36 and C35. This negative voltage level is applied to the 8 channel analog multiplexer U20 at pins 1 and 2 for switching to the differential transmitter amplifier.

c. The 8 channel analog multiplexer U20 switches RED and IR LED drive levels to the differential transmitter amplifier under the control of the timing and control section as follows: during each count of 96 51.29 KHz pulses, 3 symmetrical groups of 4 positive pulses will be output at U20 pin 3. In a similar fashion, during each count of 96 51.29 KHz pulses, 4 symmetrical groups of 3 negative pulses will be output at U20 pin 3. The two sets of pulses cannot overlap or occupy the same time slots because of the switching action of U20. Note that input channel pins 5, 13, 14 and 15 of U20 are tied to ground.

d. When neither a RED nor IR drive level is selected the transmitter outputs will be driven to a ground level to disable the transmitter. The led drive signal is applied simultaneously to a pair of unity gain amplifiers, one inverting (+LED drive) and one noninverting (-LED drive).

(1) The noninverting drive signal is fed through R51 to noise filter C94 and the positive input of U30 pin 3. The output of U30 pin 1 is applied to the bases of complementary transistors Q3 and Q4 as well as speed up capacitor C95. The output of the complementary transistors is fed back to the inverting input of U30 pin 2 to maintain unity gain as well as being applied to the +LED drive output through current limiting resistor R32.

(2) The inverting signal is applied through R53 to the inverting input of U30 pin 6. The noninverting input of U30 pin 5 is tied to isolated ground. The output of U30 pin 7 is applied to the bases of complementary transistors Q7 and Q8 and speed up capacitor C96. The output of the complementary pair is taken from the emitters and fed back to the inverting input via R52 and C93 to form a unity gain amplifier. The output is also fed to current limiting resistor R31 and output at J4 pin 4 as the -LED drive output signal. The current limiting resistor pair of R31 and R32 limit output drive signals to 75 ma.

Receiver Amplifier Section. The receiver amplifier consists of a two stage, high gain, bandpass receiver amplifier followed by a pair of demodulators and 3 pole low pass filters for signal recovery and processing. Operation is as follows:

a. The receiver diode (located in the patient finger probe assembly) is reverse biased by a +10.0 VDC reference voltage applied through R77 to the diode cathode at J5 pin 21. C68 is a low impedance filter for the +10.0 VDC reference. This circuit

minimizes dark current within the diode as a noise source for the receiver. The diode anode is applied from J5 pin 1 to the inverting input of U24 pin 2 where it functions as a positive current source with an output proportional to received light.

b. The sensitivity of U24 is controlled by R72 and is -2.21 VDC/ua of input current. C61 limits the high pass frequency of U24 to 7.0 KHz. Q1 and Q2 function as an anti-swamping network for high ambient light conditions and serve as the low pass filter for the first receiver stage.

c. R88 injects one microamp of current into U24 pin 2 to force U24 pin 1 to drive in a negative direction. When the output at U24 pin 1 reaches approximately -0.65 VDC transistor Q2 will begin to conduct current through R68 and R73 causing the voltage at the base of Q1 to go positive and allowing Q1 to conduct current through R74 into U24 pin 2. This current will be in an opposite direction to the current injected by R88 and will cancel it when the amplifiers are balanced. C62 limits the high frequency response of the anti-swamping network to 600 Hz setting the lower frequency response of U24.

d. The output of U24 pin 1 is coupled through C59 and R70 into the inverting input of the second stage amplifier U24 pin 6 where it is further amplified and output at U24 pin 7. C59 and R70 tune the low frequency response of the second stage to 625 Hz. R69 and C58 set the amplifier gain and tune the high frequency response of the second stage to a gain of approximately -19 maximum at a center frequency of 1960 hz and a high pass of 6.1 KHz. Filter combinations R71, C60 and R67, C57 are amplifier power input filters.

e. The output of U24 pin 7 is applied to one side of chopper U23 for input to the filter networks at U23 pin 6 and U23 pin 10. R76 and C79 form a smoothing network to prevent glitches when the analog signals are at a high level. The output of U24 pin 7 is also inverted by a unity gain amplifier consisting of R65, R66 and U25 (pins 1, 2 and 3) and applied to the opposite side of chopper U23 at pins 1 and 8. R81 and C90 are used to prevent high level analog glitches. The signal at this point is a combination of 1603 Hz RED information and 2137 Hz IR information modulated on a complex high-level waveform.

f. The RED signal channel is demodulated by chopping the waveform at the RED LED transmitter frequency and integrating the negative waveform pulses into a negative level representing the amount of RED light received. The IR pulses will be input as a series of AC pulses that cancel each other. The IR information is recovered in a similar manner except that the IR demodulator is chopped at a frequency of 2137 Hz.

g. The filters used to recover the RED and IR information are identical 3 pole precision low pass filters with a high frequency cutoff of 16 Hz and an AC gain of 5. R54, R57, R59, R61, R63, C51-C53 and U27 (pins 1, 2 and 3) are the IR filter elements. R58, R60, R62, R64, C48-C50 and U27 (pins 5, 6 and 7) are the RED filter elements.

h. U25 (pins 5, 6 and 7), R82 and R83 are used to develop a -2.21 VDC offset voltage which is used to bias the output of the filter amplifiers to a +8.84 VDC level when no signal voltage is present. The active range of the filters is from +8.84 VDC to approximately -9.16 VDC during signal reception. IR information is output for sampling from U27 pin 1 through R55 to U19 pin 3. RED information is output for sampling from U27 pin 7 through R56 to U19 pin 6.

Ramp Comparator Circuits: The ramp and comparator circuits consist of a precision 10.00 VDC reference, a precision ramp generator, analog sampling switches and 3 comparators used to detect voltage crossover levels for timing comparisons. The circuits function as follows:

a. The precision voltage reference U34 is used to provide a 10 VDC reference for the filter network offset bias and generation of a linear ramp with a range of +9.5 VDC in the reset condition to -10 VDC at the most negative excursion. The voltage divider network formed by R48-R50 sets the ramp reset voltage to 9.5 VDC at the junction of R48, R49 and U26-5.

b. The junction of R49 and R50 provides a test voltage of 8.45 VDC which is applied to analog multiplexer U18 pin 5 where it is used to check the span of the linear ramp as one analog to digital conversion test. R45, R46, C41, U19 (pins 9, 10 and 11) and U26 (pins 5, 6 and 7) form the elements of the linear ramp. When a positive logic level (+5 VDC) is applied to U19 pin 9 the offset voltage of 9.5 VDC at U26 pin 5 will force the output of U26 pin 7 to drive to a +9.5 VDC level, the analog switch at U19 (pins 10 and 11) will be closed and C41 will discharge through R45.

c. When the logic level at U19 pin 9 goes low (0 VDC) the analog switch will open at U19 (pins 10 and 11) and the output at U26 pin 7 will begin to drive in a negative direction at a rate determined by the values of C41 and R46 (nominally 1.2 V/ms) until the ramp reaches a value of -10 VDC at which time another reset pulse will occur and the process will repeat itself.

d. The linear ramp is applied to the positive inputs of the three sampling comparators at U29 pin 3 (stat), U28 pin 5 (IR) and U28 pin 3 (RED) where it is compared with the sampled analog values at 60.05 Hz intervals. When the 60.05 Hz sample pulse is high C46 (IR) and C45 (RED) will be charged to the voltage level present at the output of the 16 Hz filters. C43 will be charged to a voltage level which equals the input of U18 which is selected by 48H Q0 and 48H Q1.

e. The three sampled comparator inputs will be compared with the ramp voltage present on the other side of the comparators. When the ramp becomes more negative than an analog input the comparator will drive from a high logic level at its output (+15 VDC) to a low (-15 VDC) logic level. When a comparator is at a low logic level it will sink current through an optocoupler input and a series resistor to cause the optocoupler output to change logic levels from a high (+5 VDC) level to a low (0 VDC) level. The time each level is high will be monitored by a timer counter on the processor board with a maximum count greater than 60,000 counts/sample period. This gives a resolution of 325 microvolts/count for all high level analog signals.

f. The comparator outputs are routed as follows. IR is output at U28 pin 7 through R43 to U16 pin 3 input. U16 pin 6 outputs to the processor assembly via J3 pin 20. RED is output at U28 pin 1 through R44 to U17 pin 2 input. U17 pin 7 outputs to the processor assembly via J3 pin 21. Stat outputs at U29 pin 6 through R42 to U16 pin 2 input. U16 pin 7 outputs to the processor via J3 pin 19. An additional comparator is used to monitor the receiver front end amplifier.

g. R86 and R85 form a voltage divider set to -11 VDC at U26 pin 2. R84 is a high impedance resistor connected from U24 pin 1 to U26 pin 3. If the voltage output at U24 pin 1 exceeds -11 VDC the comparator output at U26 pin 1 will go low sinking current through R87 and optocoupler U17 pin 3. The output at U17 pin 6 will switch from a high (+5 VDC) to a low (0 VDC) logic level at J3 pin 30. This will be monitored by the processor assembly as an overload condition.

h. Other components in the isolated section and their functions are: R47 provides a current source for the finger probe resistance-measuring logic between the +10.0 VDC reference and J4 pin 2; C42 provides a low impedance current source for the finger probe logic to prevent glitches while switching analog channels; R40 is a current limiting resistor in series with the analog switches and the sample/hold capacitor to protect the analog switches. All other components in the isolated section are power supply filters.

2.4.2 Non Isolated Section. The non isolated section consists of the clock, digital to analog conversion, audio alarm amplifier circuits and associated logic components. U9 is an octal latch which is tied to the processor data bus and used as an output port by the processor. The timekeeping clock is a single IC (U7) that is powered by battery/system power at all times. Y1, C21, and C22 form a 32,768 Hz oscillator to provide an accurate time base for the clock. C23 prevents transients on the clock chip during power up and power down conditions. Clock functions are controlled by the microprocessor through U9. Data is output from the clock at U7 pin 9 to J3 pin 29 where it is routed to a processor input port. R23 is a pull-up resistor required for proper logic levels on the clock output.

VR1 and components R21, R22, C19 and C20 are a programmable voltage regulator set to provide +9.0 VDC (±0.27 VDC) to power U10 and provide a voltage divider reference for analog multiplexer U5. U6 is a logic level shifter to convert the 5/0 VDC logic level outputs of U9 into high level 12/0 VDC logic levels required by analog multiplexers U4 and U5. R24 is a pull-up resistor network required by the open collector outputs of U6. U5 is used to set the voltage reference on DAC U8 so an output span of 1.00, 3.00, 5.00, or 10.00 volts can be selected.

U3, R14, R15, R16 and C6 form an inverting amplifier with an adjustable gain of slightly greater than one. This allows the voltage reference between U3 pin 7 and U8 pin 15 to reach a span of -10 VDC with the +9 VDC input voltage. Other voltages available from the divider network of R17, R18, R19 and R20 will be amplified proportionately. R30 and C88 are a noise filter for the DAC reference input. The DAC acts as a current source at U11 pin 2 to drive the amplifier to a voltage equal to -[(reference voltage)xN/255] where n is a number from 0 to 255 that is loaded into the DAC by the processor. R79 and C24 are feedback components to minimize noise on the DAC output.

The output of DAC U8 is applied to the common pin of 8 channel analog multiplexer U4 for routing to the analog output and audio amplifiers. The outputs of U4 are routed to a charging capacitor and the high impedance noninverting input of 5 operational amplifiers to form a series of sample and hold inputs.

The amplifier outputs are connected back to the inverting inputs to form unity gain voltage followers. Three of the amplifier outputs are routed through current limiting resistors and filter capacitors to micro jack sockets for connection to external equipment. The output of U1 pin 1 is routed to micro jack P1 and represents a scaled version of the oxygen saturation measurement. The output of U1 pin 7 is routed to micro jack P2 and represents a scaled version of the heart rate measurement. The output of U2 pin 1 is routed to micro jack P3 and represents either a scaled version of the measured signal variations (pulse waveform) or a TTL logic level pulse rate timing pulse for external equipment synchronization. The output of U2 pin 7 is used to inject a variable current into the audio oscillator for audio tone control. The output of U3 pin 1 (via D1) is used to set the audio volume.

The rest of the audio circuit functions as follows. U10 is a 555 timer IC connected to function as a square wave generator with components R8, R9, R13 and C9 controlling the duty cycle and operating frequency. The output of U10 is taken at pin 3 and applied through R7 to the output of U3 pin 1 (via D1) and the input of the audio power amplifier at R5. C1, C7, C8, Q5, Q6, R3-R8 and U11 (pins 5, 6 and 7) form a unity gain audio amplifier capable of delivering 1.2 watts into an 8 ohm speaker.

The filter element combinations of (C8 and R3) and (C7 and R4,R6) smooth the applied square wave. C1 is a DC blocking capacitor used to couple the audio output signal to the external speaker. The speaker output is routed to J1 pins 1 and 2. VR2 is a +5.0 VDC regulator used to provide a stable power source for the optocouplers, U8 and U9. All other Analog Board components are power filtering devices.

2.5 AB18A Power Supply Board

REFERENCE DRAWING 185D153, (APPENDIX A, PAGE A-8)

The Power Supply Board converts AC line or DC battery power into DC voltages and signals required by the oximeter. The power supply may be divided into four functional areas: Power Input and Battery Charger, Power Switching and Regulation, Power Output Section and Logic Control circuits.

<u>2.5.1 Power Input and Battery Charger.</u> The Power Input and Battery Charger circuits provide unregulated system power and charge the battery as required when connected to an AC power source. The wall outlet transformer, or OMNI-TRAK 3100, provide an unregulated DC voltage of approximately 16 to 24 VDC (depending on line voltage and system load). Surge arrestor diode D12 protects system components from overvoltage conditions and line surges by clamping incoming voltages above approximately 25 VDC to ground. Power is bussed to the battery charger and the recharge LED (located on the Display Assembly via P2-8) from this point. Power is routed to the main power supply circuits thru diode D11.

a. The battery charger is comprised of VR3, U3, Q3, Q6, Q7, Q8 and associated components. Components VR3, R39, R37, R27, D35, D29, D30 and C45 form an adjustable voltage reference which is adjusted to the maximum battery charge. The adjustable reference has a voltage span of approximately 3 to 15 VDC. The diodes D35, D29 and D30 are located in the reference leg of VR3 to provide temperature compensation for the oximeter battery. C45 provides output voltage stability for the adjustable voltage reference output. U3 and associated components C43, C44, D26-D28, R35, R36 and R42-R47 form a two stage voltage comparator which is used to monitor battery voltage and control battery charger switching circuit.

b. Resistors R46 and R47 form a voltage divider with a nominal voltage of 7.6 VDC which represents an undervoltage battery condition and is applied to U3 pin 3. Resistor R36 applies the battery voltage to the other side of the undervoltage comparator at U3 pin 2. Resistor R45 connects the output of the undervoltage comparator U3 pin 1 back to the positive input of the undervoltage comparator where it is used to provide approximately 50 mV of hysteresis about the comparator threshold. This results in circuit stability when the battery undervoltage cross-over point is present. The output of the battery undervoltage comparator is low (less than 1.5 VDC) under normal battery conditions and does not affect the operation of the second (over-voltage) comparator.

c. When an undervoltage battery condition is detected the comparator output will be high (greater than 10.5 VDC) and will be applied thru D27 to U3-6 where it will override the high impedance battery input and result in the battery charger being turned off. The present battery voltage is also applied thru R35 to U3 pin 6 as a high impedance input. C44 filters this voltage for stability during comparator crossover conditions.

d. The adjustable battery reference voltage is applied to the other side of the high battery voltage comparator at U3 pin 5 through R44. The output of the high battery voltage comparator occurs at U3 pin 7 and is applied to the battery charger switching circuit thru low impedance resistor R43 and zener diode D26. D26 serves to clamp the output of the high battery voltage comparator to a maximum of 15 VDC regardless of input line voltage variations. Resistor R42 provides approximately 40 mVDC of negative hysteresis for stability as the battery approaches a fully charged condition.

e. The output of the high battery voltage comparator at U3 pin 7 will be high when the battery terminal voltage is between 7.6 and the battery reference voltage as set at the output of VR3 (normally 14 VDC). Capacitor C43 is a filter at the positive power terminal of U3. Diode D28 clamps the input at U3 pin 6 to a value no greater than Vcc + 0.7 VDC to provide a low impedance discharge path for C44 during input power down conditions.

f. When the output of the battery comparators is high the battery charger switching circuit will be turned on. A voltage of less than 11.0 VDC will be present at the

emitter of transistor Q6 and not enough current can flow through resistors R32, R33, and across diode D25 to cause transistor Q6 to saturate.

g. The voltage at the base of transistor Q7 will cause Q7 to conduct current through resistors R21, R34, R23 and across diode D22 into the battery. This will turn on transistor Q8 and apply a forward bias to the base of transistor Q3, turning Q3 on. Capacitor C46 will delay slightly the turn on (and turn off) time of transistor Q8. When transistor Q3 is turned on current will flow into L3, C36, across resistor R14, through diode D22 into the battery.

h. When approximately 0.8 ampere of current is flowing through resistors R14, a voltage large enough to turn on transistor Q5 will be developed (0.65 VDC). Resistor R20 limits the base current of Q5. When Q5 is saturated the voltage across the emitter-base junction of transistor Q7 will fall below the level required for conduction and Q7 will turn off. Transistors Q8 and Q3 will be turned off. Current will continue to flow into the battery through diode D20, L3, R14 and D22 due to the field collapse of coil L3. Capacitor C36 will also provide a current source at this time. When current flowing out of coil L3 and capacitor C36 is no longer sufficient to maintain a voltage saturating the emitter-base junction of transistor Q5, transistor Q7 will turn on and the cycle will repeat. The cycle frequency is determined by the LC time constant of L3 and C36 and is approximately 30 KHz.

i. When the battery is sufficiently charged, the voltage to the battery comparators becomes positive enough to allow the output to switch low at U3 pin 7. Enough current then flows through R32, R33 and diode D25 to turn on transistor Q6 and transistor Q7 is held in the cutoff condition until further charging is required.

j. D10 routes battery power to the main power supply circuit when AC power is not present. Diode D9 routes battery power to the printer power circuit (not active in the MRI Pulse Oximeters) and resistor R9 provides a low current power source for battery powered backup functions on the processor assembly via connector P2 pin 1.

2.5.2 Power Switching and Regulation. The Power Switching and regulation circuits consist of the regulating pulse width modulator U1, power FET Q2, transformer T1, turn-on switch Q4 and associated components C18, C19, C24, C26, C28, C29, C31, C34, C35, C39, C40, C41, C47, D15, D16, D17, D18, D19, D33, D34, R7, R8, R10, R11, R12, R16, R17, R24, R29 and R30. The power switching circuit is configured in a flyback arrangement with a duty cycle of less than 50%. Operation is as follows.

a. System input power is present at the cathode of diodes D10 and D11, through fuse F1, to power filters C18 and C19, to R12 and through the primary of T1 pins 3 to 2, through D18 to C35 and the emitter of Q4. Q4 will be biased in the off condition at this time (Ee=Eb) and no current will flow through T1 or U1 until a start pulse is applied to turn Q4 on. Capacitor C35 will be charged to the applied DC voltage level -0.65 VDC.

b. When the oximeter power on/off switch is depressed system input power is routed from P2-10 through the external power on/off switch to P2-11 through blocking diode D17, across C31 as a positive pulse through R11 where it charges C35 to a value approximately twice the input voltage. The negative plate of C31 is held to a zero VDC potential by R8. Q4 will now be biased on and apply power to U1 pin 13, U1 pin 15 and C34.

c. The voltage applied to U1 pin 15 will activate the internal circuits of U1. A +5.0 VDC (±1%) 50 ma voltage regulator is output at pin 16 and used to provide a precision voltage reference for the noninverting input of the internal error amplifier at pin 2, a low impedance power source via D16 and P2-1 for system battery powered functions (clock and memory), and a 1.6 VDC preset source for the soft start circuitry consisting of D33, D34 and C47. U1's on board oscillator will begin to operate at a frequency of approximately 90 KHz as determined by the values of R29, R30 and C39. The combination of R29 and C39 determine the oscillator charge time which is typically 10 micro-seconds. The combination of R30 and C39 determine the oscillator discharge time as well as the minimum amount of dead time per pulse period (10%). Because only 1/2 of U1's output drivers are used, the regulator's operating frequency will be approximately 45 KHz with a 45% maximum duty cycle.

d. Output driver A of U1 will not begin to operate at full power until the soft start current source at U1 pin 8 has charged capacitor C47 from zero to a high logic level (>3.3 VDC). A minimum supply level of 8 VDC is required to ensure full turn-on of power FET Q2 (Resistor R16 limits inrush current due to Q2's gate capacitance to less than 500 ma to protect U1's output driver from damage). When Q2 turns on current will flow through the primary and secondary windings of T1. The fields in the secondary windings of T1 will reverse bias the rectifiers in the power output section at this time so no current will flow into the secondary circuits.

e. When output driver A goes low Q2 will turn off, opening the primary of T1, and the fields generated during the turn on period will collapse (reverse) causing T1's winding voltages to flyback, forward biasing the output section rectifiers. Current will flow into the secondary storage capacitors until the energy induced by the turn-on pulse is depleted. C24 and C26 will charge towards a 12 VDC level at this time. The voltage on C24 and C26 is routed to filter C40 and voltage divider network R10 and R17. The values of R10 and R17 are set where 12 VDC is applied to R10 the voltage at U1 pin 1 will equal 5.0 VDC (±2%).

f. C41 acts as a high frequency noise filter. Voltage differences between U1 pins 1 and 2 will cause output driver A's pulse widths to vary, thereby controlling the energy delivered to T1 and regulating the output voltages. The network of C28, C29 and R7 form a compensation network that controls the gain of U1's internal error amplifier at different frequencies. This network has been selected to allow maximum gain at low frequencies and minimize response to high frequency noise. During the flyback period a small, positive voltage is induced at T1-2. This voltage is rectified by D18

and stored in C35 to keep Q4 turned on when the power supply is operating. D19 limits the voltage to Q4 to 25 VDC to protect U1.

2.5.3 Power Output Section. The Power Output Section consists of T1's secondary windings, rectifiers D2 through D8, D13, D14, and D15, Capacitors C1 through C16, C23 through C27, and C30, Inductors L1 and L2, and regulators VR1 and VR2. Output power is divided into system power and isolated power groups.

a. For system power rectifier D15, Capacitors C24 and C26 rectify and filter +12 VDC (±0.25 VDC) from T1 windings 1 and 6. This power is used as a feedback to regulate the power switching circuit as previously described and is output to the system via P2 (pins 3 and 5). In a similar manner T1 (pins 1 and 5), D14, C30 and C27 provides -12 VDC to P2 (pins 15 and 16) and T1 (pins 1 and 4), D13, C23 and C25 provides +5 VDC to P2 (pins 2 and 4) for system use.

b. The isolated power section provides an isolation barrier for added patient safety. All isolated secondary windings share a common ground at T1 pin 9 and are on a single multi-tapped winding. T1 pin 7, D7, C9, and C12 rectify and filter +18 VDC as previously described.

c. The additional filter components of L2 and C16 provide added filtering of high frequency ripple. +18 VDC (±1.5 VDC is output at P1 (pins 13 and 14). T1 pin 11, D2, C1, C2, L1 and C3 provide a complementary -18 VDC (±1.5 VDC) output at P1 (pins 1 and 2). T1-8, D6, C10 and C11 provide +7.5 VDC to linear regulator VR2 which provides +5.0 VDC (±0.25 VDC) power to C15 and P1 (pins 11 and 12). T1 pin 10, D5, C7, C8, VR1 and C14 work in an identical manner to provide -5.0 VDC (±0.25 VDC) power to P1 (pins 1 and 2). T1 pin 12, D3, C4 and C6 provide -39 VDC. R1, C5 and D8 form a parallel voltage regulator which provides -36 VDC (±2.0 VDC) to P1 (pins 3 and 4). Components R2, R3, D4, C13, C29 and R4 form a divider network used to sample the the head voltage present at T1 (pins 2 and 3). This is a test output routed to P1 pin 5. All isolated outputs are routed to the isolated section of the oximeter analog board assembly via connector P1. Capacitor C17 is a variable high voltage trimming capacitor used to inject a small portion of the input switching voltage to the isolated secondary for high frequency noise cancellation.

2.5.4 Control and Logic Circuits. The Control and Logic circuits are comprised of the remaining power supply components and supply various signals required for oximeter system operation. The circuit consisting of C32, D31, R18, R19, R25, R26 and one section of operational amplifier U2 forms a power low interrupt circuit to warn of low battery conditions so the system may be shut down before information is lost. R18 and R19 form a voltage divider set to equal 5.0 VDC when the battery voltage equals 10.4 VDC and is applied to the negative side of the comparator at U2 pin 6. The +5.0 VDC reference developed by regulator U1 pin 16 is applied to the positive side of the comparator at U2 pin 5. As long as the battery voltage remains over +10.4 VDC the comparator output will be low (-12 VDC). When the battery output falls below +10.4 VDC the battery comparator will go high (+12 VDC). Operation is as follows.

The output of the battery comparator is taken at U2 pin 7, routed through a voltage divider network of R25 and R26 to P2-12 where it is used to generate a processor interrupt in the oximeter processor assembly. Diode D31 is used to clamp the -12 VDC low output of the comparator to a ground level for input to the processor logic circuits. C32 and C48 provide noise immunity at the comparator crossover point. Note that the unregulated DC input overrides the battery input when AC line power is applied to the oximeter. R28 and D32 are active when external power is applied to prevent spurious low battery warnings. A microprocessor shutdown input is provided at P2 pin 6 allowing external control of switching regulator U1 pin 10. When a shutdown signal is received at P2 pin 6 it is routed through D21 to P2 pin 14 where it is used to generate hardware reset signals by the oximeter processor. When the oximeter power switch is depressed positive voltage generated at P2 pin 11 is also routed through R6 to P2 pin 13 where it is sent to an input port on the processor assembly. This signal is monitored periodically by the processor and when high (+5 VDC) is used to initiate a processor controlled shutdown of the power supply. R5 is a pull-down resistor to insure the signal is low when the external power switch is not depressed.

SECTION III

MAINTENANCE

This section provides maintenance information of the 4500 MRI Pulse Oximeter.

3. MAINTENANCE

3.1 Disassembly and General Service Precautions.

CAUTION

A thorough understanding of each of the following precautions is necessary before attempting to perform any disassembly or service procedure. Damage to the instrument, or injury to personnel, may result if these precautions are not used.

1. Use caution when working on units with power applied.
2. Avoid rough handling of all exposed chassis parts and front panel overlay. These parts can be scratched causing obtrusive cosmetic defects.
3. Patient input circuits have floating ground sections for patient isolation. Avoid handling this section of the circuit boards as oils, sweat, dirt, etc. can cause leakage paths to be formed which destroy the safety isolation and/or reduce performance.
4. Handle all printed circuit boards by their edges. Oils, sweat, dirt, etc. can induce leakage paths in high impedance circuits which impede their operation. Such contamination will also promote corrosion of circuits yielding a long term reliability problem.
5. Assembly hardware has been secured with a thread locking agent. After several assembly/disassembly cycles new locking agent will be required. (Use only locking agent Loctite 42540 or similar type for use near PVC or acrylic plastics.)
6. The Pulse Oximeter contains a great many STATIC SENSITIVE circuits. Proper handling procedures must be followed when touching any printed circuit board as static voltages usually present on clothing and personal present great risk of damage to the circuits. All service procedures must be done by properly grounded personal at static free work stations.
7. When cleaning the unit, do not permit liquid to enter the case. When cleaning and handling keep contaminants from printed circuit boards. Use proper materials and assure total dryness before powering back up. Be careful that cleaning fluids do not attack plastic or painted surfaces. Also be careful that wiping rags do not abrade surfaces.

3.2 Adjustment and Verification

CAUTION

Shorting of power supply voltages can blow the protection fuse (a small pico fuse) located on the Power Supply Board. Use extreme care when probing the various test points.

3.2.1 Adjustment and Verification Setup. Reference paragraphs 3.2.1.1 and 3.2.1.2 prior to performing any Adjustment and Verification procedure.

3.2.1.1 Test Equipment Required. The following test equipment is required to perform adjustment and verification of the 4500 Pulse Oximeter:

DVM	4.5 digit minimum
Oscilloscope	Tek 2245 - 20 MHz Dual Channel (or better)

3.2.1.2 Power Connection. If using Pulse Oximeter Model 3109-1, refer to step a; if using Pulse Oximeter Model 3109-3, refer to step b.

a. Connect DB25 power adapter cable to "IN" connector on rear panel of unit. Connect other end to DC Power supply and set output voltage to nominal 24 volts DC. Verify recharge LED on front display panel is ON.

b. Connect HE28B power adapter cable to "IN" connector on rear panel of unit. Plug the other end into wall socket. Verify recharge LED on front display panel is ON.

3.3.2 Battery Reference Adjustment and Verification. The following procedure is to be used for Adjustment and Verification of the Pulse Oximeter Model 3109-3 only.

REFERENCE APPENDIX A FOR BOARD AND/OR COMPONENT LOCATIONS.

a. The battery reference voltage adjustment set point is determined by ambient temperature (room temp.). Determine the ambient temperature and reference **Table 3-1** for the adjustment set point.

NOTE

Access to the test points can be made from the side of the Power Board by using due care.

Table 3-1: Adjustment Set Point

Ambient Temperature (Tc)		Set Point (VDC)
°F	°C	
70	21.1	14.026
72	22.2	14.018
75	23.8	14.008
77	25	14.000
80	26.6	13.990

NOTE

Use a $^1/_4$ watt resistor lead pushed into top of J1 connector to obtain a ground. Do not lift the connector.

b. Connect DVM Ground to Analog board J1 pin 2 (digital ground).

c. On the Power Board, monitor TP3 (Battery Reference) and adjust R37 for SET POINT (**Table 3-1**) ±0.010 volts. Adjust pot CW to decrease and CCW to increase.

3.2.3 System Power Supply Adjustment and Verification. Perform the following for adjustment and verification of the Power Supply.

REFERENCE APPENDIX A FOR BOARD AND/OR COMPONENT LOCATIONS

a. With monitor connected to variable power supply set to nominal 24 VDC, verify recharge LED on front panel display is ON.

b. Connect DVM Ground lead to Analog Board J1 pin 2 (Digital Ground).

c. Press POWER STANDBY.

d. On the Processor Board, monitor J4 pin 1 (PRT V) and adjust R38 for 5.5 VDC ±0.05 V. Adjust pot CW to decrease and CCW to increase.

e. Perform the following test to verify proper voltage levels on both the isolated and unisolated supplies:

(1) Connect DVM Ground lead to Digital Ground (J1 pin 2 of Analog board).

(2) Set PROCESSOR TEST switch (DEFEAT switch, P3 on Processor Board) to TEST position.

(3) Using the DVM, verify the following voltages:

Test Point	**Voltage**	**Tolerance**
Processor Board J4 pin 1	+5.5 VDC	±0.1V
Processor Board C33 (+)	+5.5 VDC	±0.5V
Analog Board C29 (+)	+5.0 VDC	±0.5V
Analog Board C19 (+)	+9.0 VDC	±0.9V
Analog Board L1-1	+12.0 VDC	±0.6V
Analog Board L2-1	-12.0 VDC	±2.0V

f. Move DVM ground lead to Analog Board J5 pin 3 (ISO Ground) and verify the following Iso voltages:

Test Point	**Voltage**	**Tolerance**
Analog Board C78 (+)	+5.0 VDC	±0.5V
Analog Board Q3-C	+5.0 VDC	±0.5V
Analog Board C76 (+)	+15.0 VDC	±0.75V
Analog Board C77 (-)	-15.0 VDC	±0.75V
Analog Board C62 (-)	-39.0 VDC	±3.0V
Analog Board U34 pin 6	+10.0 VDC	±0.2 V

g. Depress POWER STANDBY switch.

h. Verify the following:

(1) Front Panel display segments go off, then back on.

(2) SYSTEM STATUS display indicates "NO Turn Off".

i. Set PROCESSOR TEST Switch to NORMAL position.

j. Depress POWER switch.

k. Verify normal unit power off.

3.2.4 System Reset Verification. Perform the following procedure to verify system reset.

REFERENCE APPENDIX A FOR BOARD AND/OR COMPONENT LOCATIONS.

a. Unplug J4 connector on Processor Board.

b. Depress POWER switch.

c. Verify unit displays "Hello" then automatically goes back off.

d. Reconnect connector J4.

3.2.5 Ground Noise Adjustment. Some ground noise difference may arise between the isolated and non-isolated supply grounds. Capacitor C17 is used to minimize this difference. Such ground difference noises can induce noise onto the pulse signal from the sensor. Perform the following procedure for adjustment of ground noise.

REFERENCE APPENDIX A FOR BOARD AND/OR COMPONENT LOCATIONS.

a. Connect oscilloscope Ground reference to Analog Board J1 pin 2 (Digital Ground).

b. Connect oscilloscope channel 2 probe to Analog Board J5 pin 3 (ISO Gnd).

c. Set Ch 2 amplitude to 0.5V per division and time base to 5 us per division.

d. Connect Ch 1 probe to leg of C17 near JMP 1 or test point at JMP 1 on Power Supply Board.

e. Set Ch 1 amplitude to 10V per division and time base to 5 us per division.

f. Sync on channel 1 and view channel 2.

g. Adjust C17 for minimum step, less than 50 mV.

3.2.6 Battery Charger Circuit Test. To test the battery charger circuit on the model 3109-3 Pulse Oximeter, perform the following:

REFERENCE APPENDIX A FOR BOARD AND/OR COMPONENT LOCATIONS.

a. Connect a DC power supply to the battery terminals.

b. Set DC supply to 11.8 volts ±0.1 volt.

c. Press POWER STANDBY switch on unit.

d. Verify that unit does not display "Batt Low" in the SOS display.

e. Decrease DC power supply till SOS displays "Batt Low".

f. The DC supply should be set at 11.25 volts ±0.50 volts.

g. Decrease the DC power supply till the unit shuts down.

h. The DC supply should be set at 10.70 volts ±0.50 volts.

i. Turn off DC power supply.

j. Disconnect the DC power supply from the unit.

k. Reconnect battery.

<u>3.2.7 Front Panel Verification.</u> To verify Front Panel operation, perform the following:

REFERENCE APPENDIX A FOR BOARD AND/OR COMPONENT LOCATIONS.

a. Depress POWER STANDBY switch.

b. Verify normal power up.

c. Depress OPTIONS switch.

d. Verify SYSTEM STATUS display indicates '**Fil=xxsc**' (xx is 3, 6 or 12).

e. Depress UP Arrow switch.

f. Verify xx increments through 3, 6 and 12 each time the switch is depressed then repeats.

g. Depress DOWN Arrow switch.

h. Verify xx decrements through 12, 6, 3 with each time the switch is depressed then repeats.

i. Depress CANCEL switch and verify displays return to normal.

j. Press the OPTIONS switch five times and verify '**Rev.MX__**' is indicated in SYSTEM STATUS display.

<u>3.2.8 Processor and Analog Verification.</u> To verify Processor and Analog functions perform the following:

REFERENCE APPENDIX A FOR BOARD AND/OR COMPONENT LOCATIONS

a. Connect frequency counter to U15 pin 3 on Analog Board.

b. Set the frequency counter to 51.29 ±0.01 KHz.

c. Depress the ALARM SELECT switch 7 times to select the ALARM volume control.

d. Verify that SYSTEM STATUS display indicates "**aVol=__**".

e. Depress the UP or DOWN Arrow switches.

f. Verify the following:

   (1) Full volume range of alarm tone from 10% to 100%.

   (2) The alarm is silent when OFF is selected.

g. Depress the Options switch until "**Analog ^**".

h. Depress the UP or DOWN Arrow switch until status displays "**VOLT=10V**".

i. Depress the OPTIONS control.

j. Verify SYSTEM STATUS display indicates "**SaO2 OFF**".

k. Connect DVM to SaO2 analog output at U1 pin 1 of Analog Board.

l. Depress the DOWN Arrow switch once.

m. Verify SYSTEM STATUS display indicates "**SaO2 100**".

n. While monitoring DVM, adjust R15 on analog board for 10.0V ±20mv.

o. Depress the DOWN Arrow switch.

p. Verify voltage drops 100mv ±20mv with each count of one in the SYSTEM STATUS display.

q. Depress UP or DOWN Arrow leaving SaO2 set to 100.

NOTE

"SaO2 100" must be selected and indicated in the SYSTEM STATUS display or voltage verifications will not be correct.

r. Depress the CANCEL control.

s. Perform the following:

(1) With the Options switch reselect "**Analog** ^".

(2) Depress the DOWN Arrow switch and select the 1 volt output range (VOLT=1V).

(3) Depress OPTIONS control.

(4) Verify SYSTEM STATUS display indicates "**SaO2 100**" and DVM reads 1 V ±20 mV.

t. Depress the CANCEL control.

u. Perform the following:

(1) With the Options switch reselect "**Analog** ^".

(2) Depress the DOWN Arrow switch and select the 3 volt output range (VOLT=3V).

(3) Depress OPTIONS control.

(4) Verify SYSTEM STATUS display indicates "**SaO2 100**" and DVM reads 3.0 V ±60 mV.

v. Depress the CANCEL control.

w. Perform the following:

(1) With the Options switch reselect "**Analog** ^".

(2) Depress the DOWN Arrow switch and select the 5 volt output range (VOLT=5V).

(3) Depress OPTIONS control.

(4) Verify SYSTEM STATUS display indicates "**SaO2 100**" and DVM reads 5.0 V ±100 mV.

x. Depress the OPTIONS switch twice.

y. Verify that SYSTEM STATUS display indicates "**Pr Wave**". (If "**Pr Sync**" is indicated on the SYSTEM STATUS display, depress the UP or DOWN Arrow to turn it off.)

z. Depress the CANCEL switch.

aa. Move DVM connection to Pulse/Sync at U2 pin 1 of the Analog Board.

ab. Depress OPTIONS switch until "**Analog**" is reselected in the SYSTEM STATUS display.

ac. Depress the UP Arrow to select the 10V range (VOLT=10V).

ad. Depress OPTIONS switch three times.

ae. Verify SYSTEM STATUS display indicates "**PULSE255**" (if necessary depress UP Arrow to select 255).

af. Verify DVM reads 10.0 V ±20 mV.

ag. Depress UP Arrow once.

ah. Verify SYSTEM STATUS display indicates "**OFF**" and DVM reads 0 V ±20 mV.

(1) Verify for each press of the UP Arrow switch that the SYSTEM STATUS display increments by one and the DVM reading increases 40 mV.

3.2.9 System Self Test. Perform the following to accomplish System Self Test:

REFERENCE APPENDIX A FOR BOARD AND/OR COMPONENT LOCATIONS.

a. Simultaneously press BLANK switch (below OPTIONS) and ALARM switch (SW4 & SW5) and verify the following.

(1) Oxygen Saturation & Pulse Rate displays will count from 0 - 999 then repeat and during 0's leading 0s are blanked.

(2) Bargraph will increase from minimum to maximum then repeat illuminating all segments of bargraph and audio pulses from a Hi to low tone.

(3) SYSTEM STATUS will change its display every second, indicating upper & lower alpha, numerical and graphics characters and then will also repeat.

b. Test provides a direct display of the 16 bit A/D conversion on the pulse and SaO2 displays. Each count is equal to 300 uV. Conduct the following test with probe shielded from external light.

c. Depress upper left Blank switch and then depress Alarms switch (these switches turn off the IR and RED transmitters). Red Amp is now selected. Verify that the SaO2 display doesn't change more than ±10 and pulse display is 0.63 ±0.01.

d. Depress the UP Arrow switch. The IR Amp is now selected. Record the numbers in the SaO2 and PULSE RATE display and verify that the SaO2 display doesn't change more than ±10 and pulse display is 1.63 ±0.01.

e. Depress CANCEL switch. Verify unit returns to normal operation (dashes in left displays and time alternating with NO Probe in the SYSTEM STATUS display.

<u>3.2.10 Functional Verification.</u> To verify proper function of the Pulse Oximeter, perform the following:

REFERENCE APPENDIX A FOR BOARD AND/OR COMPONENT LOCATIONS.

a. Place probe on finger.

(1) Verify SaO2 display reads ≥ 90.

(2) Verify normal pulse rate displayed in PULSE RATE display with no "Off Cal", "Artifact", or Low Light" in the SYSTEM STATUS display.

(3) Verify "Probe Off" in SYSTEM STATUS display when finger is removed from probe.

b. Remove probe from finger.

(1) Open probe and apply a bright light to sensor.

(2) Verify SYSTEM STATUS displays "ProbeOFF" instead of "Probeoff" indicating an overload condition detected.

APPENDIX A: REFERENCE DRAWINGS

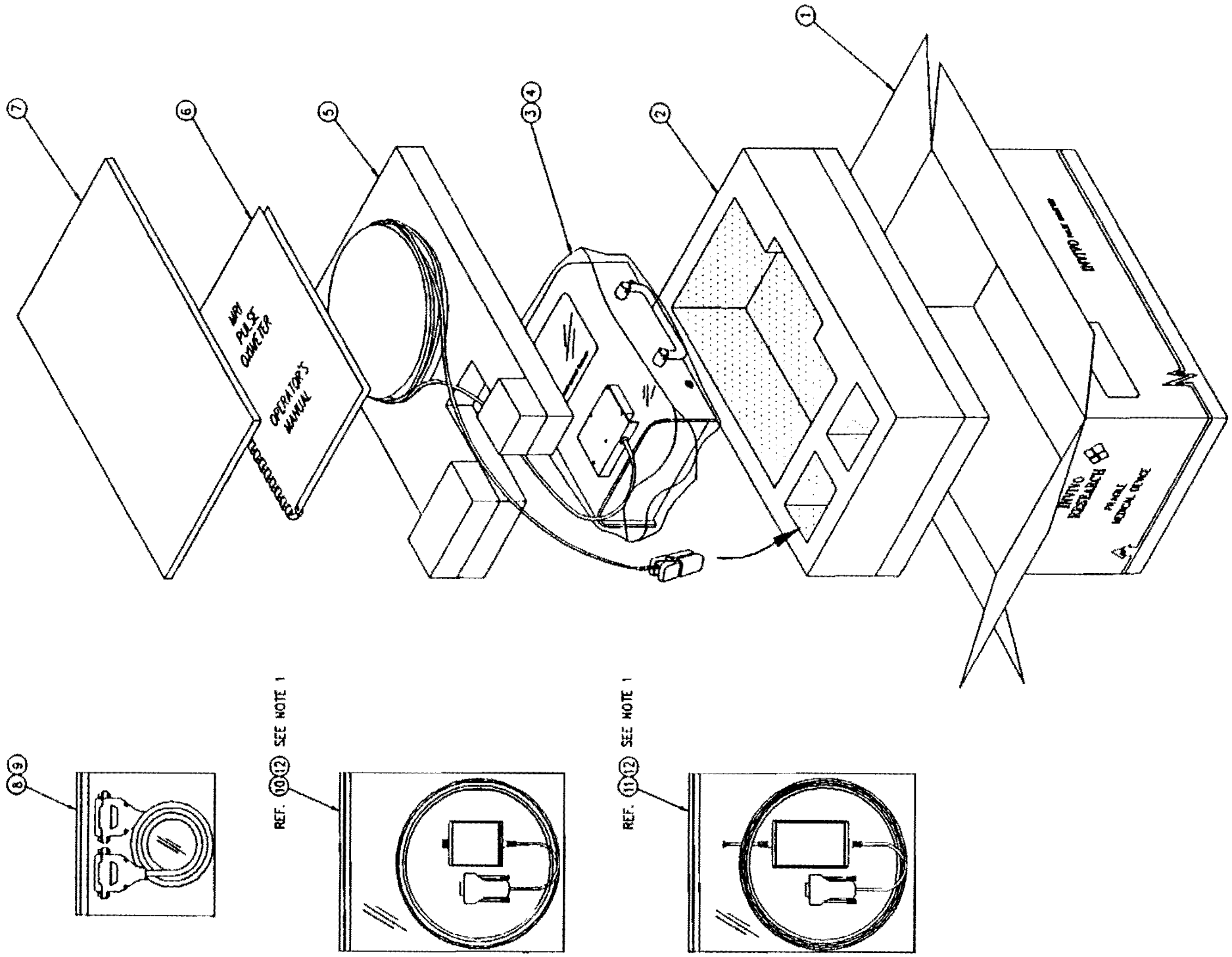


CHART		
ITEM	3109-1	3109-3
3	AF48	AF48A
8	AC203	—
9	M001B	—
10 (REF.)	—	HE28B
11 (REF.)	—	HE31B
12 (REF.)	—	M0010

LOCATION	PART NO.	QTY.	DESCRIPTION
12 (REF.)	SEE CHART	1	BAG, ZIPLOCK, 10" X 13" X 2.00 MIL
11 (REF.)	SEE CHART	1	AC ADAPTER ASSY, 9 PIN, 230V, MRI OXIMETER
10 (REF.)	SEE CHART	1	AC ADAPTER ASSY, 9 PIN, 120V, MRI OXIMETER
9	SEE CHART	1	BAG, ZIPLOCK, 8" X 8" X 1.75 MIL
8	SEE CHART	1	CABLE ASSEMBLY, 12', CO2 OR MRI INTERFACE
7	M077B	1	INSERT, CARDBOARD, PACKING, MRI OXI
6	9521	1	MANUAL, OPERATOR'S, MRI OXIMETER
5	M077	1	POLYFOAM PACKING, TOP, MRI OXI
4	M001	1	BAG, CLEAR 20" X 24" X .002
3	SEE CHART	1	ASSY, OXIMETER, 4500, MRI
2	M077A	1	POLYFOAM PACKING, BOTTOM, MRI OXI
1	M078	1	BOX, SHIPPING, MRI OXIMETER

REV	DESCRIPTION	BY	DATE
D	PER ECN #3146	SR	9/92
C	PER ECN #2716	SLP	1/91
B	PER ECN #2575	SLP	9/90
A	PER ECN #2354	SLP	8/90

DRAWN	SLP	1/90
CHECKED	SLP	1/90

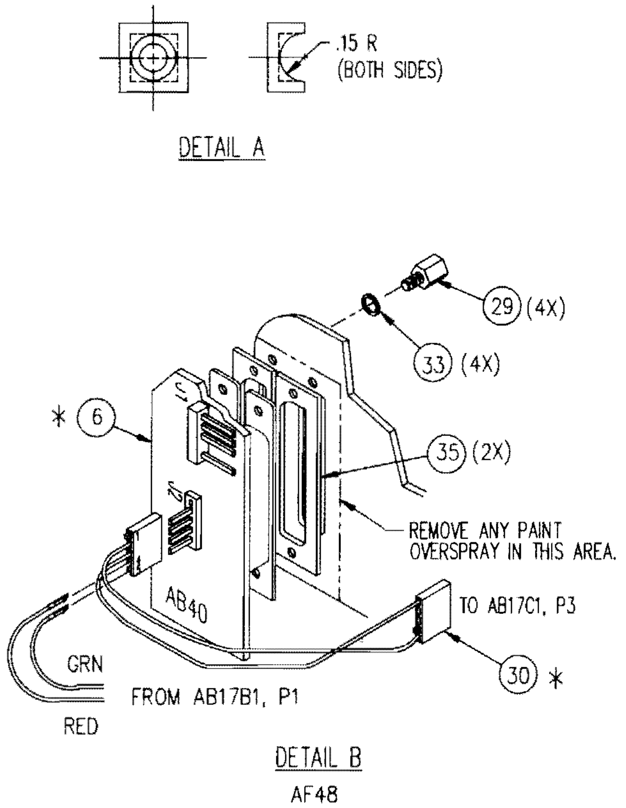
INVIVO RESEARCH INC.
12601 Research Parkway
Orlando, Florida 32826

PROCESS AND INSTR. 3109-1 AND 3109-3 MRI OXIMETER OPTION AND MRI 4500A, STAND-ALONE

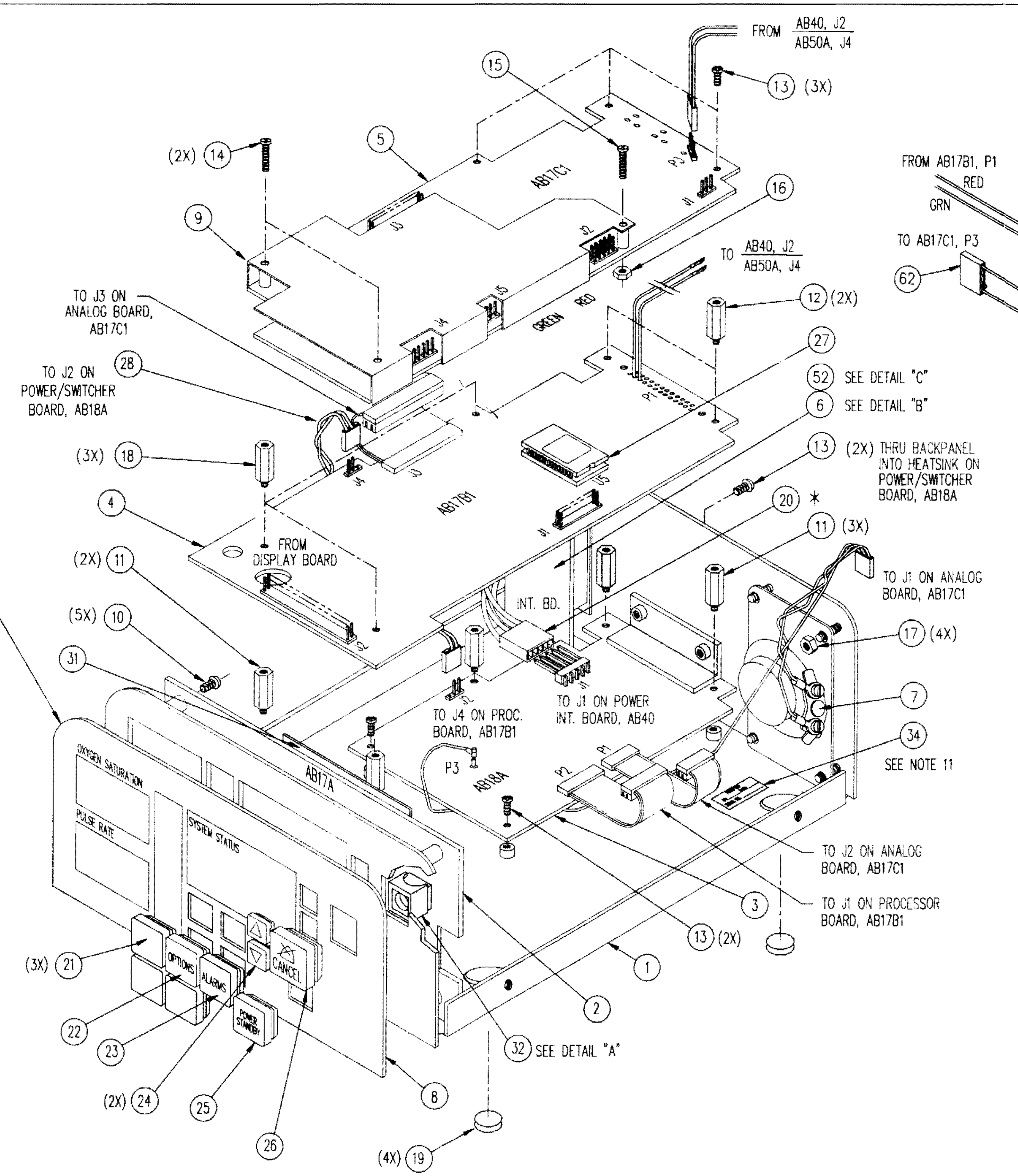
SCALE 1-1 | SHEET 1 OF 1 | DWG NO. C970372 | REV D

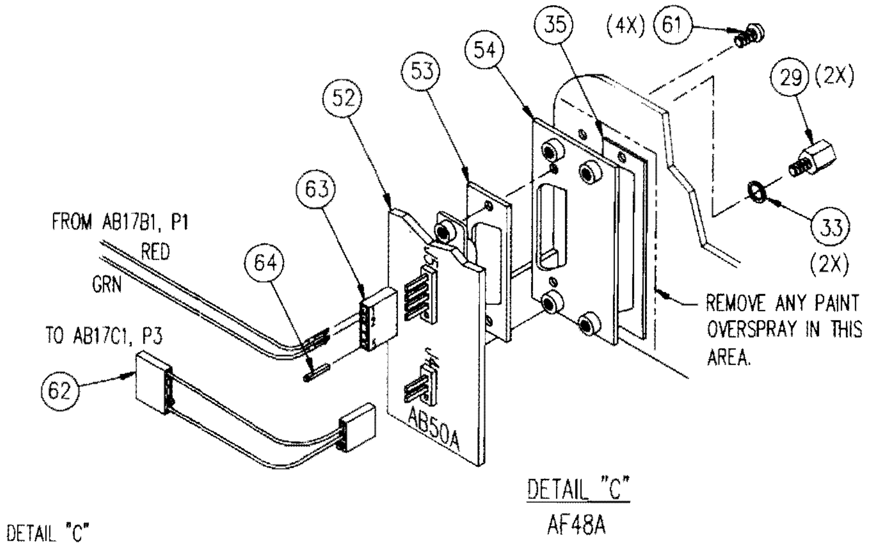
NOTES

1. PLACE EITHER ONE (1) HE28B, 120V ADAPTER OR ONE (1) HE31B, 230V ADAPTER IN BOX, DEPENDING ON ORDER.



BE SURE TO REMOVE PROTECTIVE BACKING FROM CONDUCTIVE ADHESIVE AREAS (2X)





USE "ASSURE" LOC-TITE, P/N M006/M050 ON ALL THREADS EXCEPT WHERE NOTED OTHERWISE.

ASSEMBLY NOTES:

1. INSTALL FEET, P/N FE02 (ITEM 19) ONTO BOTTOM OF CHASSIS, P/N HM26A (ITEM 1).
2. INSTALL SPEAKER ASSEMBLY, P/N AS72 (ITEM 7) ONTO BACKPANEL USING FOUR (4) NUTS, P/N N006 (ITEM 17).
3. PLACE EMI/RFI GASKETS, P/N PA186 (ITEM 35) ONTO DB25 CONNECTORS ON POWER INTERCONNECT BOARD, P/N AB40 (ITEM 6), THEN ASSEMBLE BOARD TO BACKPANEL USING FOUR (4) LOCKWASHERS, P/N NW09 (ITEM 33), FOUR (4) MALE/FEMALE SCREWLOCKS, P/N HS28 (ITEM 29), AND FOUR (4) NUTS, P/N N002 (ITEM 30), AS SHOWN.
4. APPLY OVERLAY, P/N L809 (ITEM 8) TO FRONT OF CHASSIS. SNAP BUTTONS, P/N H007, H008, H09C, E, F, & G (ITEMS 21-26) THRU THIER APPROPRIATE HOLES IN FACE OF CHASSIS AS SHOWN.
5. CUT OR NOTCH OUT TWO (2) OPPOSITE SIDES OF SWITCH SHROUDS, P/N HM14S (ITEM 32) PER DETAIL "A". PLACE SWITCH SHROUDS OVER APPROPIATE SWITCHES ON DISPLAY BOARD P/N AB17A (ITEM 2) WITH NOTCHED PORTION TOWARDS TOP AS SHOWN. SECURE DISPLAY BOARD TO CHASSIS USING FIVE (5) SCREWS, P/N NS04 (ITEM 10). INSTALL INSULATOR, P/N HI16 (ITEM 31) ONTO BACK OF DISPLY BOARD, USING THE CENTER MOUNTING SCREW.
6. APPLY HEAT SINK COMPOUND TO HEATSINK ON POWER/SWITCHER BOARD, P/N AB18A (ITEM 3) AND INSTALL INTO BOTTOM OF CHASSIS USING THREE (3) STANDOFFS, P/N HS30 (ITEM 11) AND TWO (2) SCREWS, P/N NS02 (ITEM 13). ALIGN HOLES IN HEATSINK WITH HOLES IN BACKPANEL AND SECURE WITH TWO (2) SCREWS, P/N NS02 (ITEM 13).
7. ROUTE THE LONG BLACK WIRE OF THE SPEAKER ASSEMBLY UNDER CORNER OF POWER/SWITCHER BOARD AS SHOWN AND CONNECT TO P3 ON THAT BOARD. CONNECT POWER INTERCONNECT CABLE, P/N AC216 (ITEM 20) FROM POWER/SWITCHER BOARD AT J1 TO POWER INTERCONNECT BOARD, ALSO AT J1.
8. INSTALL TWO (2) STANDOFFS, P/N HS30 (ITEM 11) IN BOTTOM OF CHASSIS BEHIND DISPLAY BOARD. INSTALL PROCESSOR BOARD, P/N AB17B1 (ITEM 4) ONTO THOSE STANDOFFS AND THE STANDOFFS SECURING THE POWER/SWITCHER BOARD USING TWO (2) STANDOFFS, P/N HS15 (ITEM 12) AND THREE (3) STANDOFFS, P/N HS36 (ITEM 18), AS SHOWN. CONNECT RIBBON CABLE FROM POWER/SWITCHER BOARD AT P2 TO PROCESSOR BOARD AT J1. CONNECT RIBBON CABLE FROM DISPLAY BOARD AT P1, TO PROCESSOR BOARD AT J2, ROUTING DOWN INSULATOR AT BACK OF DISPLAY BOARD. INSTALL PROM SET, P/N AM35 (ITEM 27) INTO SOCKET AT U5 LOCATION ON PROCESSOR BOARD. CONNECT POWER PRINTER CABLE, P/N AC141 (ITEM 28) FROM POWER/SWITCHER BOARD AT J2 TO THE PROCESSOR BOARD AT J4.
9. PLACE ANALOG SHIELD, P/N HM14P (ITEM 9) OVER ANALOG BOARD, P/N AB17C1 (ITEM 5), THEN SECURE WITH SCREW, P/N NS54 (ITEM 15) AND NUT, P/N N001 (ITEM 16), AS SHOWN. INSTALL ANALOG BOARD ONTO THE STANDOFFS (SECURING THE PROCESSOR BOARD) USING THREE (3) SCREWS P/N NS02 (ITEM 13) AND TWO (2) SCREWS, P/N NS53 (ITEM 14), AS SHOWN. CONNECT RIBBON CABLE FROM PROCESSOR BOARD AT J3 TO ANALOG BOARD, ALSO AT J3. CONNECT SPEAKER ASSEMBLY CABLE TO ANALOG BOARD AT J1, WITH RED WIRE AT PIN 1 LOCATION. CONNECT RIBBON CABLE FROM POWER/SWITCHER BOARD AT P1, TO ANALOG BOARD AT J2.
10. CONNECT CABLE FROM PROCESSOR BOARD AT P1, TO POWER INTERCONNECT BOARD AT J2 AND ANALOG BOARD AT AT P3.
11. ATTACH ACCEPTANCE LABEL, P/N L014 (ITEM 34) (INFORMATION WRITTEN BY HAND) TO INSIDE OF CHASSIS AT RIGHT REAR, BELOW SPEAKER ASSEMBLY.

* – COMPONENTS NOT REQUIRED FOR AF48A ASSEMBLY

★ – QUANTITIES DIFFER BETWEEN AF48 & AF48A. FIRST NUMBER = AF48, SECOND NUMBER = AF48A.

REF. QTY. IN PARENTHESIS ( ) IN ASSY. VIEW.

AF48A ADDITIONAL PARTS LIST

64	PA12	1	KEY PLUG (.10)
63	PA19	1	HOUSING, SR, 5 PIN (.10)
62	AC240	1	CAB, ANALOG TO SAT POWER INT. BD.
61	NS04	4	SCREW, #4-40 X 1/4" PH PNHD ZINC PLD
54	HM26C	1	ADAPTER PLATE, DB9, MRI OXIMETER
53	PA202	1	GASKET, EMI/RFI, 9 PIN CONNECTOR
52	AB50A	1	PCA, SAT POWER INTERCONNECT, MRI

LOCATION	PART NO.	QTY.	DESCRIPTION
★ 35	PA186	2/1	GASKET, EMI/RFI, 25 PIN
34	L014	1	LABEL, ACCEPTANCE
★ 33	NW09	8/6	LOCKWASHER, INT. TOOTH, #4 SS
32	HM14S	9	CHS., OXIMETER, SWITCH SHROUDS
31	HI16	1	INSULATOR, DISPLAY OXIMETER
* 30	AC222	1	CAB, ANALOG TO POWER INT. BD.
★ 29	HS28	4/2	SCREWLOCK, FEMALE, #4-40 X .312"
28	AC141	1	CABLE, PRINTER POWER, OXIMETER
27	AM35	1	PROM SET, OXIMETER, 4500MRI
26	H008	1	BUTTON, .7 X .55 CANCEL
25	H009F	1	BUTTON, .5 X .45 POWER STANDBY
24	H007	2	BUTTON, .4 X .35 ARROW
23	H009E	1	BUTTON, .5 X .45 ALARMS
22	H009C	1	BUTTON, .5 X .45 OPTIONS
21	H009G	3	BUTTON, .5 X .45 BLANK
* 20	AC216	1	CABLE, POWER INTERCONNECT, OXI-MRI
19	FE02	4	FEET, GRAY SJ-5012
18	HS36	3	STANDOFF, #6-32 X .75" MALE/FEMALE NYLON
17	N006	4	NUT, HEX, #2-56, ZINC PLD
★ 16	N001	1/2	NUT, HEX, #6-32, ZINC PLD
15	NS54	1	SCREW, #6-32 X 1.00" PH PNH ZINC PLD
14	NS53	2	SCREW, #6-32 X 1.00" SL PNH NYLON
★ 13	NS02	7/9	SCREW, #6-32 X 1/4" PH PNH ZINC PLD
12	HS15	2	STANDOFF, #6-32 X 3/4"
11	HS30	5	STANDOFF, #6-32 X 1.00"
★ 10	NS39	5/5	SCREW, #4-40 X 7/16" PH PNH ZINC PLD
9	HM14P	1	CHS., OXIMETER, ANALOG SHIELD
8	L809	1	OVERLAY, 4500MRI, OXIMETER
7	AS72	1	ASSEMBLY, SPEAKER, OXIMETER
* 6	AB40	1	PCA, POWER INTERCONNECT, OXI-MRI
5	AB17C1	1	PCA, ANALOG PULSE OXIMETER, MRI
4	AB17B1	1	PCA, PROCESSOR PULSE OXIMETER, MRI
3	AB18A	1	PCA, POWER/SWITCHER PULSE OXIMETER, MRI
2	AB17A	1	PCA, DISPLAY PULSE OXIMETER
1	HM26A	1	CHS., BOTTOM, OXIMETER FOR MRI

REV.	DESCRIPTION	BY	DATE
E	PER ECN NO. 3421	CHY	4/93
D	PER ECN NO. 3383M	SR	10/92
C	PER ECN NO. 3146	CHY	5/92
B	PER ECN NO. 2575	SLP	10/90
A	PER ECN NO. 2354	JRN	5/90

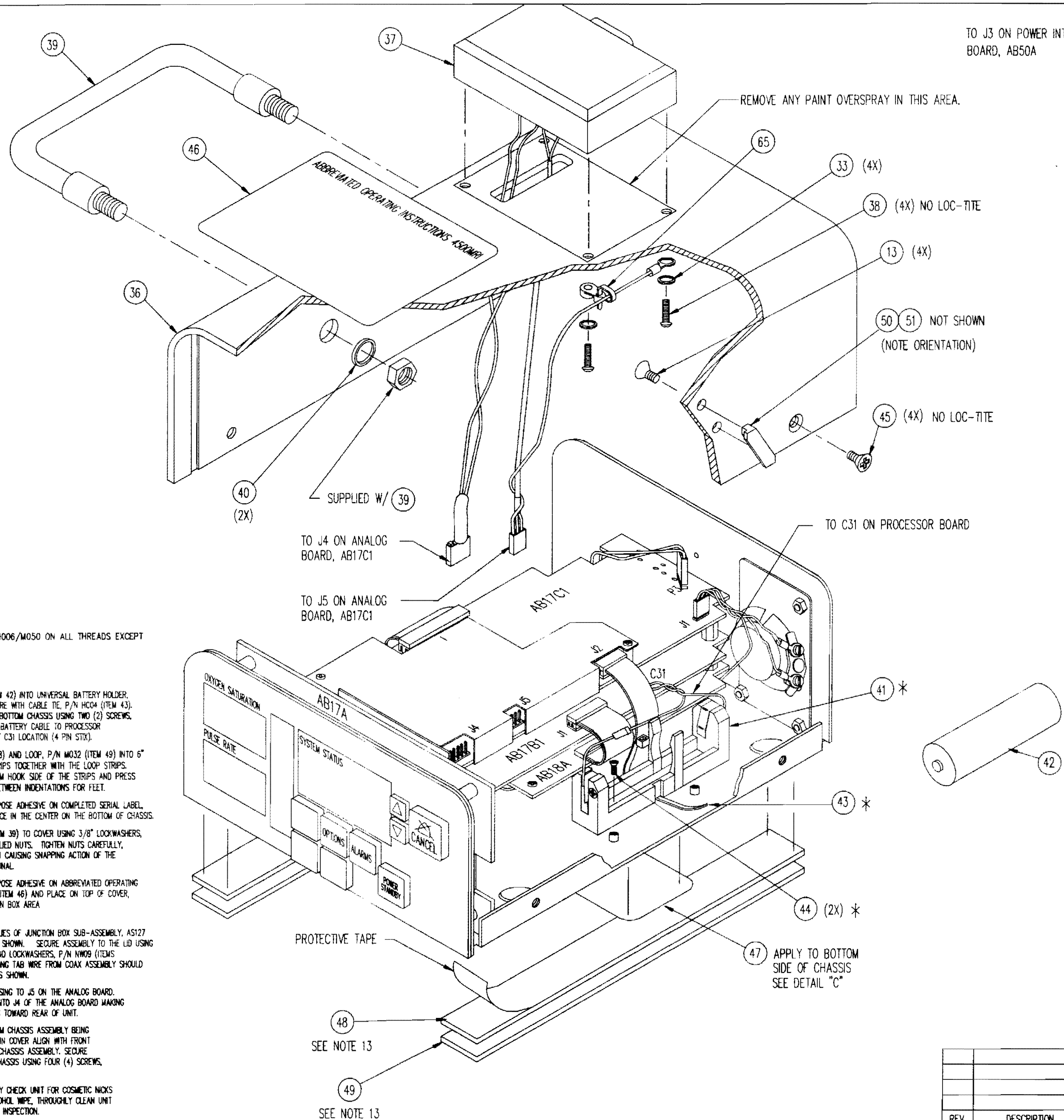
UNLESS SPECIFIED TOLERANCES ARE

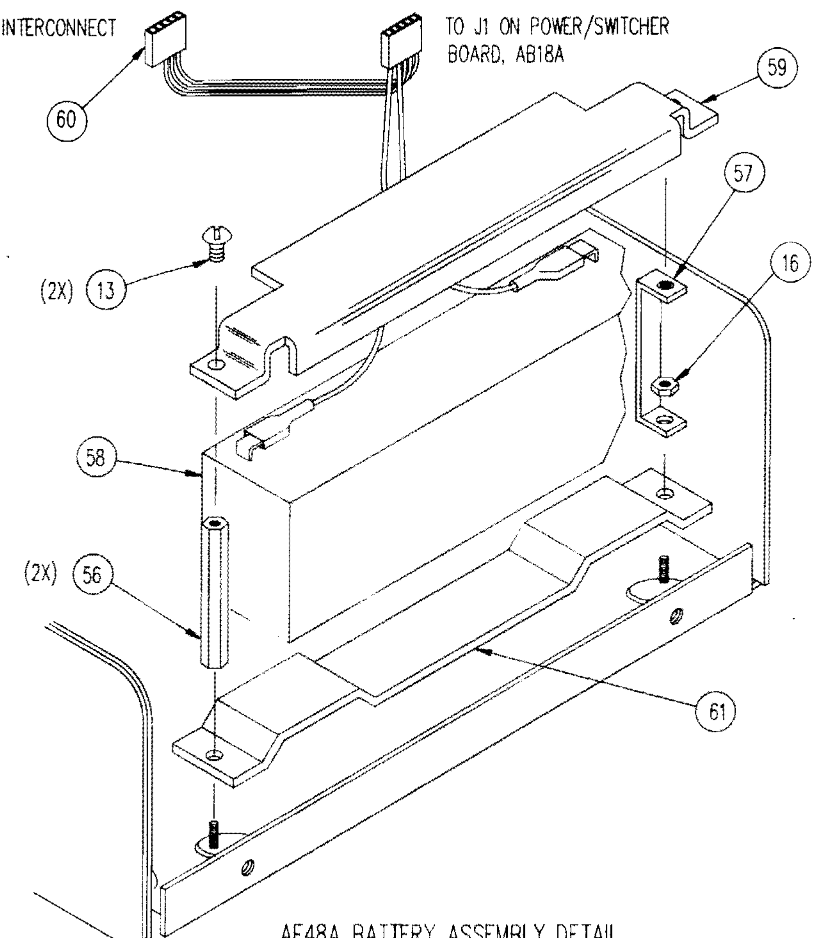
DRAWN	JRN	2/90
DESIGNED	JRN	2/90
CHECKED		
APPROVED		

INVIVO RESEARCH INC.
4420 METRIC DRIVE SUITE A
WINTER PARK, FLORIDA 32792

TITLE ASSEMBLY: AF48/AF48A OXIMETER, 4500, MRI

SCALE	SHEET	DWG. NO.	REV.
NA	1-2	194D543	E





AF48A BATTERY ASSEMBLY DETAIL

60	AC238	1	CAB, SAT POWER INTRCONN./BATTERY, MRI OXIMETER
59	HM26D	1	BRACKET, BATTERY, MRI OXIMETER
58	HB03	1	BATTERY, 12V, 2.3AH
57	HM26F	1	BRACKET, SPACER, BATTERY MOUNT, MRI OXIMETER
56	HS02	1	STANDOFF, HEX, F/F, #6-32 X 2.25"
55	HM26E	1	SPACER, BATTERY, MRI OXIMETER

REF. QTY. IN PARENTHESIS ( ) IN ASSY. VIEW.

* = COMPONENTS NOT REQUIRED FOR AF48A ASSEMBLY

LOCATION	PART NO.	QTY.	DESCRIPTION
65	HC07	1	CABLE TIE, #4 TY533M
51	HM40A	1	BRACKET, LH, POLE MOUNT (NOT SHOWN)
50	HM40	1	BRACKET, RH, POLE MOUNT
49	M032	12"	FASTENER, LOOP, BLACK, 1" WIDE
48	M031	12"	FASTENER, HOOK, BLACK, 1" WIDE
47	L803A	1	LABEL, SER. NO., 15-30V, OXIMETER
46	L816	1	LABEL, ABBRIVIATED OP-INSTRUCTIONS 4500MRI
45	NS63	8	SCREW, 6-32 X 1/4" PH FLH ZINC PLD
* 44	NS19	2	SCREW, #6-32 X 3/8" PH FLH SS
* 43	HC04	1	TIE, CABLE
* 42	HB00	1	BATTERY, 4.5V NEDA1306A
* 41	AS03A	1	ASSY.,BATTERY HOLDER,, MRI
40	NW07	2	LOCKWASHER, EXTERNAL TOOTH, 3/8"
39	HH01	1	HANDLE, FOLDING, SPRING DETENT
38	NS17	4	SCREW, 4-40 X 1/2" PH PNH ZINC PLD
37	AS127	1	SUB-ASSY, JCT. BOX, MRI DUAL F.O.
36	HM26B	1	CHS., COVER, OXIMETER FOR MRI

USE "ASSURE" LOCTITE, P/N M006/M050 ON ALL THREADS EXCEPT WHERE NOTED OTHERWISE.

ASSEMBLY NOTES CONTINUED:

12. PLACE BATTERY, P/N HB00 (ITEM 42) INTO UNIVERSAL BATTERY HOLDER, P/N AS03A (ITEM 41) AND SECURE WITH CABLE TIE, P/N HC04 (ITEM 43). SECURE BATTERY ASSEMBLY TO BOTTOM CHASSIS USING TWO (2) SCREWS, P/N NS15 (ITEM 44). CONNECT BATTERY CABLE TO PROCESSOR BOARD, P/N AB17B1 (ITEM 4) AT C31 LOCATION (4 PIN STIX).

13. CUT HOOK, P/N M031 (ITEM 48) AND LOOP, P/N M032 (ITEM 49) INTO 6" STRIPS. PLACE THE HOOK STRIPS TOGETHER WITH THE LOOP STRIPS. REMOVE PROTECTIVE TAPE FROM HOOK SIDE OF THE STRIPS AND PRESS FIRMLY TO BOTTOM OF UNIT BETWEEN INDENTATIONS FOR FEET.

14. REMOVE PAPER BACKING TO EXPOSE ADHESIVE ON COMPLETED SERIAL LABEL, P/N L803A (ITEM 47) AND PLACE IN THE CENTER ON THE BOTTOM OF CHASSIS.

15. ATTACH HANDLE, P/N HH01 (ITEM 39) TO COVER USING 3/8" LOCKWASHERS, P/N NW07 (ITEM 40) AND SUPPLIED NUTS. TIGHTEN NUTS CAREFULLY, ENSURING NOT TO OVER TIGHTEN CAUSING SNAPPING ACTION OF THE HANDLE TO BECOME NONFUNCTIONAL.

16. REMOVE PAPER BACKING TO EXPOSE ADHESIVE ON ABBREVIATED OPERATING INSTRUCTION LABLE, P/N L816 (ITEM 46) AND PLACE ON TOP OF COVER, CENTERED IN FRONT OF JUNCTION BOX AREA

17. SLIP UNDERSIDE CABLE ASSEMBLIES OF JUNCTION BOX SUB-ASSEMBLY, AS127 (ITEM 37) THRU SLOT IN LID AS SHOWN. SECURE ASSEMBLY TO THE LID USING FOUR (4) SCREWS, P/N NS17 AND LOCKWASHERS, P/N NW09 (ITEMS 33 & 38) NOTING THAT GROUNDING TAB WIRE FROM COAX ASSEMBLY SHOULD BE SECURED TO THE CHASSIS AS SHOWN.

18. CONNECT 3 POSITION COAX HOUSING TO J5 ON THE ANALOG BOARD. CONNECT 6 POSITION HOUSING INTO J4 OF THE ANALOG BOARD MAKING SURE THAT PIN ONE POSITION IS TOWARD REAR OF UNIT.

19. SLIDE COVER DOWN OVER BOTTOM CHASSIS ASSEMBLY BEING SURE THAT SLOTTED CHANNELS IN COVER ALIGN WITH FRONT AND BACK PANELS OF BOTTOM CHASSIS ASSEMBLY. SECURE COVER ASSEMBLY TO BOTTOM CHASSIS USING FOUR (4) SCREWS, P/N NS63 (ITEM 45) AS SHOWN.

20. AFTER COMPLETION OF ASSEMBLY CHECK UNIT FOR COSMETIC NICKS AND SCRATCHES. USING AN ALCOHOL WIPE, THROUGHLY CLEAN UNIT AND SUBMIT TO FINAL TEST AND INSPECTION.

REV.	DESCRIPTION	BY	DATE

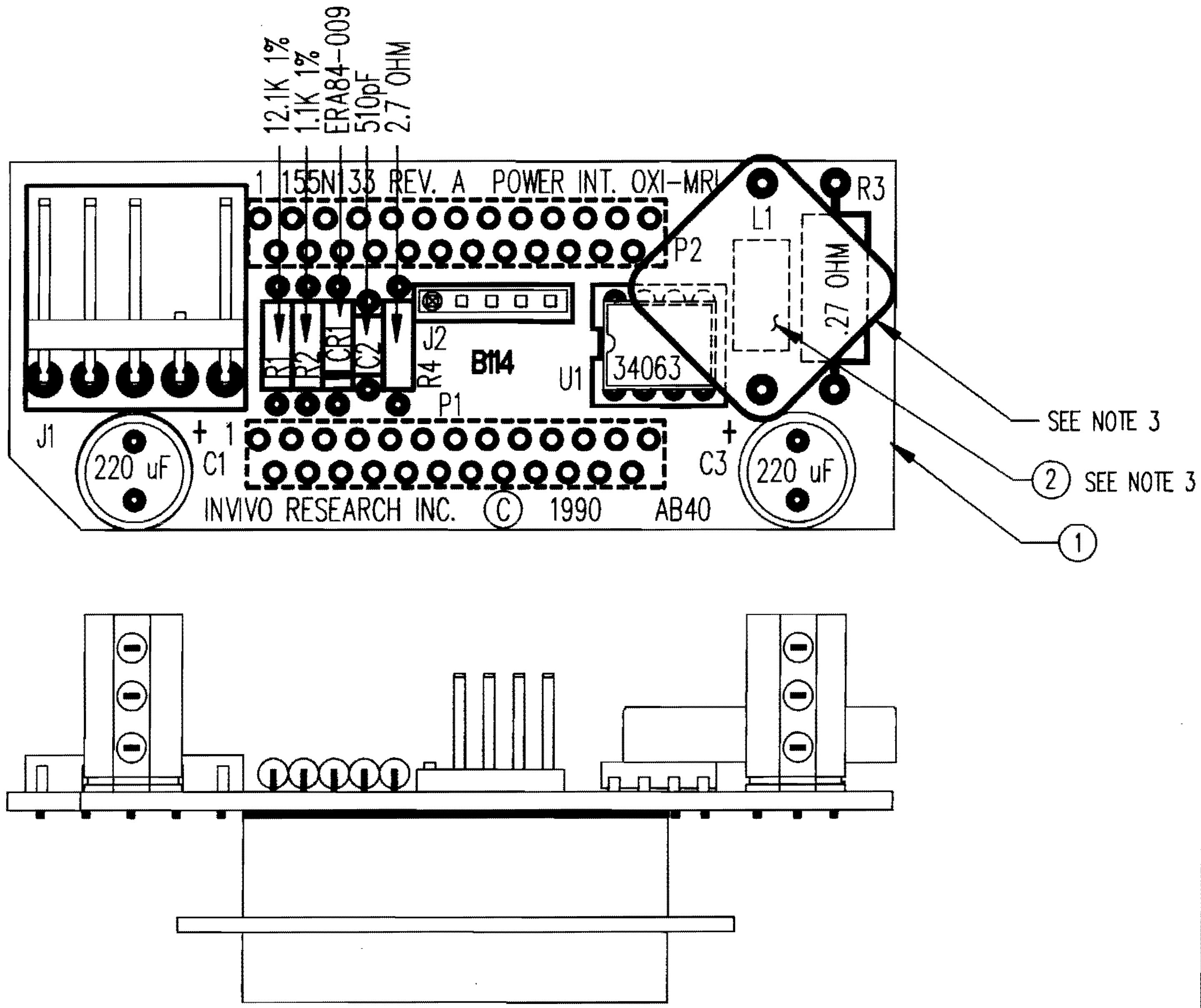
UNLESS SPECIFIED TOLERANCES ARE

DRAWN	JRN	2/90	
DESIGNED	JRN	2/90	
CHECKED		5/93	
APPROVED		5/93	

INVIVO RESEARCH INC.
4420 METRIC DRIVE SUITE A
WINTER PARK, FLORIDA 32792

TITLE ASSEMBLY: AF48/AF48A OXIMETER, 4500, MRI

SCALE	SHEET	DWG. NO.	REV.
NA	2-2	194D543	E



NOTE:
1. CUT PINS AT J1-PIN 4 AND J2-PIN 1 AS INDICATED AT BOARD ASSEMBLY AND INSPECTED AT QC LEVEL.
2. P1 AND P2 TO BE ASSEMBLED ON SOLDER SIDE AS SHOWN.
3. "J" HOOK BOTH LEADS ON INDUCTOR (T040). "J" HOOK TWO (2) BUS WIRES AND CONNECT TO "J" HOOKED LEADS ON INDUCTOR (T040) AND SOLDER. USE ENOUGH 3/8" x 3/16" PIECES OF M000, TAPE, (ON TOP OF ONE ANOTHER) UNTIL INDUCTOR (T040) IS CUSHIONED AND RESTS SECURELY ON CONVERTOR (IR04). THEN SOLDER INDUCTOR (T040) IN LOCATION L1 AS SHOWN.

LOCATION	PART NO.	QTY.	DESCRIPTION
2	M000	.095FT	TAPE, D.F. 3/8" x 1/16"
L1	T040	1	INDUCTOR, 330uH, 1.0 AMP
J2	PA06	1	HEADER UNSH 5 PIN .10
J1	PA121	1	HEADER UNSH 5 PIN .156
U1	IR04	1	CONVERTER, DC TO DC MC34063AP1
CR1	D007	1	SHCOTTKY ERA 84-009
R4	R010	1	RES., 2.7 OHM 5% .25W CF
R3	RF169	1	RES., .27 OHM, 1%, 1W, WW
R2	RF73	1	RES., 1.1K 1% .125W MF
R1	RF93	1	RES., 12 K, 1%, .125W, MF
C2	CC38	1	CAP., 510 pF 5% 50V COG AXIAL
C1, C3	CA15	2	CAP., 220 uF ±20% 35VDC AL. RADIAL
P1, P2	PA181	2	FILTER, DB25 RECEPTACLE, PCB MOUNT
1	B114	1	PCB, POWER INTERCONNECT, OXI-MRI 155N133 REV.A

REV.	DESCRIPTION	BY	DATE
F	PER ECN NO.3052	CHY	10/24/91
E	PER ECN NO. 2669M	CHY	12/90
D	PER ECN NO. 2611M	SLP	10/90
C	PER ECN NO. 2505	SLP	8/90
B	PER ECN NO. 2484M	SLP	7/90
A	PER ECN NO. 2320	SLP	4/90

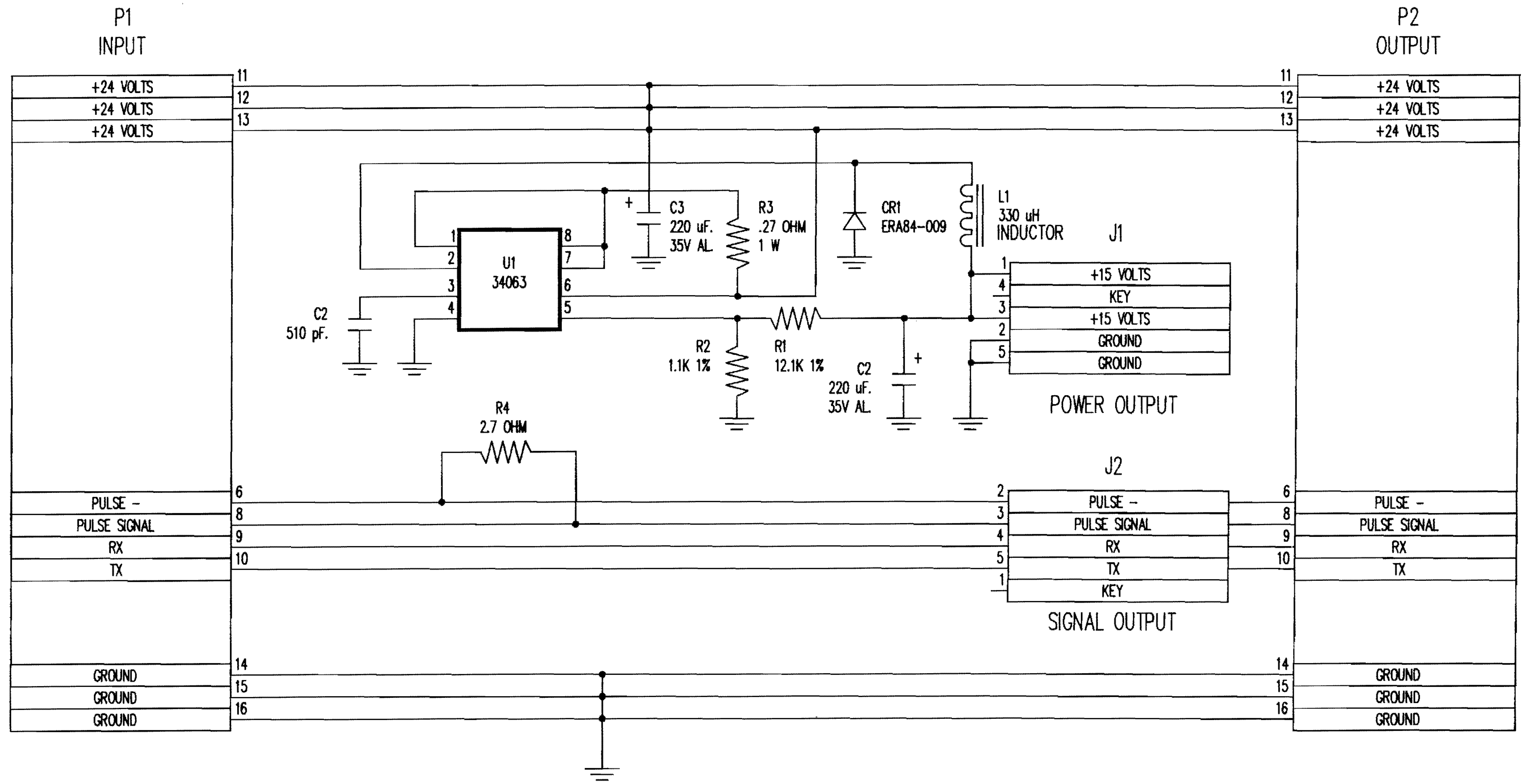
UNLESS SPECIFIED TOLERANCES ARE
X = ±.030
XX = ±.015
XXX = ±.005
ANGLES = 1/2 DEGREE
FRACTIONS
<12" = ±1/32 >12" = ±1/16

DRAWN	JRN	2/90
DESIGNED	JRN	2/90
CHECKED		
APPROVED		

INVIVO RESEARCH INC.
12601 Research Parkway
Orlando, Florida 32826

TITLE
ASSEMBLY: AB40
POWER INTERCONNECT, OXIMETER FOR MRI

SCALE	SHEET	DWG. NO.	REV.
2=1	1-1	194B542	F



REV.	DESCRIPTION	BY	DATE
C	PER ECN NO. 3052	CHY	10/24/91
B	PER ECN NO. 2669M	CHY	12/90
A	PER ECN NO. 2484M	JN	7/90

LOCATION	PART NO.	QTY.	DESCRIPTION

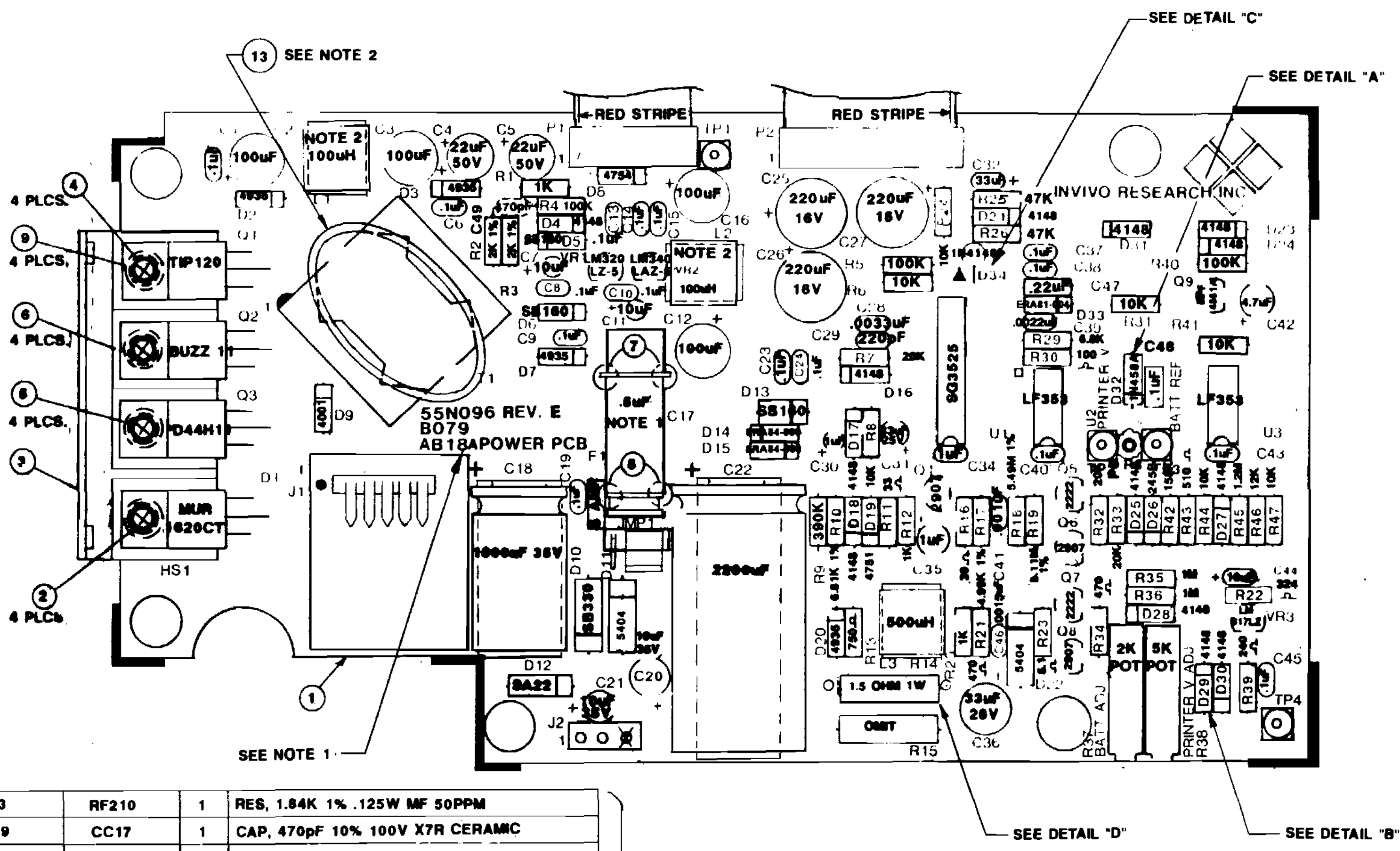
UNLESS SPECIFIED TOLERANCES ARE
X = ±.030
XX = ±.015
XXX = ±.005
ANGLES = 1/2 DEGREE
FRACTIONS
<12" = ±1/32 >12" = ±1/16

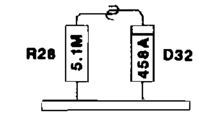
DRAWN	JRN	2/90
DESIGNED	JRN	2/90
CHECKED		
APPROVED		

INVIVO RESEARCH INC.
12601 Research Parkway
Orlando, Florida 32826

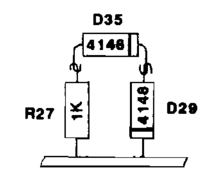
TITLE SCHEMATIC: AB40
POWER INTERCONNECT PCB, OXI-MRI

SCALE	SHEET	DWG. NO.	REV.
NA	1-1	185B149	C

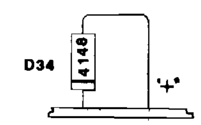




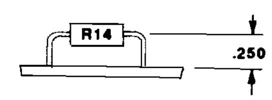
DETAIL "A"



DETAIL "B"



DETAIL "C"



DETAIL "D"

R3	RF210	1	RES, 1.84K 1% .125W MF 50PPM
C49	CC17	1	CAP, 470pF 10% 100V X7R CERAMIC
12	M004	3 5/8"	TAPE, DS, 1/2" X .010
11	HI23	4	INSULATOR, GLASS BEAD
10	WT07	1 5/8"	HEAT SHRINK, 3/64" ID BLACK
C44	CT17	1	10MF ±20%, 35V, TANT.
R44	RF07	1	10K ±1%, .125W, MF
R22	RF26	1	324 OHM ±1%, .125W, MF
AMP 1	PA28	1	STIX, RIGHT ANGLE, 3 PIN
	PA08	1	SHUNT, 2 POSITION 2-530153-2
8	HS20	2	SPACER, NYLON .065 X .140 X .350
7	HS19	2	SPACER, NYLON .065 X .140 X .319
C42	CT14	1	4.7uF 20% 16V TANTALUM
C31,36	CT03	2	33uF 20% 25V TANTALUM
C28	CP13	1	.0030uF 5% POLYESTER
D8	DZ14	1	ZENER 1N4754 40V
T1	TO84	1	ISO SECONDARY XFMR, OXIMETER
TP1-4	PA09	4	STIX, 1 PIN, .5" 103321-1
D19	DZ16	1	ZENER 1N4751 30V 1W
D9	D061	1	POWER 1N4001
C29	CC02	1	220pF 20% 50V Z5U CERAMIC
3	HQ07	1	HEAT SINK, POWER BOARD @ AB16
2	NS26	4	#4-40 X 3/8" PH PHIL PLD ZINC
L1,2	T003	2	COIL, 100UH 10% E4062-A
L3	T004	1	COIL, 500uH 10% E4063-A
R35,36	R128	2	RES, 1 MEG .25W 5% CF
R39	R127	1	RES, 240 OHM .25W 5% CF
R23	RO79	1	RES, 5.1 OHM .25W 5% CF
C47	CC55	1	CAP, .22uF, 10%, 50V, X7R
R14	R076	1	RES, 1.2 ohm, ±5%, 1W, M.O.
R13	RO75	1	RES, 750 OHM .25W 5% CF
P3	PA123	1	DISCONNECT PIN 60874-1
R9	R114	1	RES, 200K 5% .25W CF
R11	RO92	1	RES, 33 OHM, .25W 5% CF
C17	CD01	1	.8pF TRIMMER CAP GQL8R500
6	HI01	6	INSULATOR, THERMALLOY # 54-77-2
5	HI03	4	BUSHING NYLON 851647P015
U2,3	IL06	2	LF353N DUAL OP AMP

PARTS LISTED ARE FOR REFERENCE ONLY

ASSEMBLY NOTES

1. USING WHITE INDELIBLE INK OR PAINT, CHANGE BOARD ASSEMBLY NUMBER TO READ AB18A, AS SHOWN.
2. SECURE TRANSFORMER SHIELD P/N HO70 (ITEM 13) TO BOARD USING RTV ADHESIVE.
3. AT R18 REPLACE P/N RF103 WITH P/N RF214.
4. AT R14 REPLACE P/N R076 WITH P/N R169 CRIMPING THE LEADS AS REQ'D TO OBTAIN .250 HEIGHT AS INDICATED IN THE SIDE VIEW DETAIL.
5. AT R9 INSTALL P/N R117.
6. AT R25 INSTALL P/N R129.
7. AT R28 REPLACE P/N R002 WITH P/N R129.
8. AT D26 REPLACE P/N DZ03 WITH P/N DZ08.
9. AT C32 REPLACE P/N CC12 WITH P/N CT03.
10. AT D29, LIFT ANODE END AND SPLICE IN P/N R001 (RES, 1K 5% .25W CF) AND P/N D000 (SIGNAL 1N4148) AS SHOWN IN DETAIL "B".
11. AT D32, LIFT CATHODE END AND SPLICE IN P/N R155 (RES, 5.1 MEG 5% .25W CF) AS SHOWN IN DETAIL "A".
12. AT J1 REPLACE THE MODIFIED P/N PA121 WITH A NEW P/N PA121 AND ADD INDELIBLE WHITE INK DOT AT PIN 1.

LOCATION	PART NO.	QTY	DESCRIPTION
13	H070	1	SHIELD, TRANSFORMER, AB18A
R28	R155	1	RES, 5.1 MEG 5% .25W CF
R27	R001	1	RES, 1K 5% .25W CF
R25, R26	R129	2	RES, 47K 5% .25W CF
R18	RF214	1	RES, 5.49 MEG 1% .25W MF
R14	R169	1	RES, 1.5 OHM 5% 1W M. O.
R9	R117	1	RES, 390K 5% .25W CF
J1	PA121	1	HEADER, UNSH, RA, SR, 5 PIN (.156)
D35	D000	1	SIGNAL 1N4148
D26	DZ08	1	ZENER 1N5245B
C32	CT03	1	CAP, 33uF 20% 25V TANT
1	AB16	1	PCA, POWER SWITCHER, OXIMETER

BILL OF MATERIALS FOR AB18A

PARTS LISTED IN THIS B.O.M. ARE FOR REFERENCE ONLY

LOCATION	PART NO.	QTY.	DESCRIPTION
D32	D004	1	DIODE, GENERAL PURPOSE, 1N458A
R29	R074	1	RES, 6.8K 5% .25W CF
R18	RO52	1	RES, 36 OHM .25W 5% CF
R30	RO48	1	RES, 100 OHM .25W 5% CF
R43	RO43	1	RES, 510 OHM .25W 5% CF
R21,34	RO33	2	RES, 470 OHM .25W 5% CF
R42	RF43	1	RES, 158K 1%, .125W, MF
R7,32,33	RO22	3	RES, 20K .25W 5% CF
R46	RO21	1	RES, 12K .25W 5% CF
R45	RO13	1	RES, 1.2 MEG .25W 5% CF
4	NC03	4	NUT, CAPTIVE 4-40 KF2-440
41, 47 R6,8,24-26 31	R002	8	RES, 10K .25W 5% CF
R1,12,20,	R001	3	RES, 1K .25W 5% CF
R4,5 40	R009	3	RES, 100K .25W 5% CF
R37	RP14	1	RES, 2K POT 89PR2K
R38	RP16	1	RES, 5K POT 89PR5K
R16	RF103	1	RES, 2.21 MEG .25W 1% MF
R17	RF20	1	RES, 4.99K .125W 1% MF
R19	RF100	1	RES, 5.11 MEG .333W 1% MF
R10	RF04	1	RES, 6.81K .125W 1% MF
R2,3	RF01	2	RES, 2K .125W 1% MF 50PPM
Q9	QO39	1	MPF4861A JFET
Q2	QO32	1	BUZZ 11 SIPMOS POWER FET
Q1	QO36	1	TIP120 NPN DARLINGTON
Q3	QO26	1	D44H11 NPN SILICON POWER PAK
C40	CC39	1	.0015uF 10% 100V X7R CERAMIC
Q4 5 8	Q001	3	MPS2907A PNP
Q6,7	Q000	2	MPS2222A NPN
J1	PA121	1	STIX, 5 PIN RIGHT ANGLE 67965-5
J2	PA08	1	STIX, 3 PIN 1/2" 103321-3
VR2	IR41	1	LM340LAZ-5 POSTIVE REGULATOR
VR1	IR40	1	LM320LZ- 5 NEGATIVE REGULATOR
VR3	IR09	1	LM317LZ POSITIVE REGULATOR
U1	IR07	1	SG3525AN PULSE WIDTH MODULATOR
F1	FU14	1	5 AMP PICO 255005
D33	DOO8	1	DIODE, SCHOTTKY, 1 AMP 40V ERA81-004
D5 D6 D13	DO30	3	SCHOTTKY SB160
D11 D22	DO17	2	RECTIFIER 1N5404
D1	DO16	1	RECTIFIER MUR1620CT 200V
D2 3 7 20	DO18	4	RECTIFIER 1N4935 200V
D10	DO14	1	SCHOTTKY SB390
D14 D15	D007	2	SCHOTTKY ERA84-009
D4, 16-19, 21, 23-25, 27-31, 34	D000	14	SIGNAL 1N4148
D26	DZ03	1	ZENER 1N758A 10V
D12	BZ07	1	TRANSORBE SA22
C7,11,20,21	CT13	4	10uF 20% 35V TANTALUM
C30 C35	CT09	2	1uF 20% 35V TANTALUM
C39	CP16	1	.0022uF 5% POLYESTER
9	HW16	4	WASHER, NYLON #4 X .250 O.D. X .062
C1,6,8,9,10,13,14, 15,19,23,24,32,34, 37,38,40,43,45,46	CC12	19	.1uF 20% 50V Z5U CERAMIC
C41	CC05	1	.001uF 10% 50V X7R CERAMIC
C22	CA15	1	2200uF - 10/50% 35V ALUMINUM
C18	CA17	1	1000uF - 10/50% 35V ALUMINUM
C4 C5	CA06	2	22uF 50V ALUMINUM
C25,26,27	CA07	3	220uF - 10/50% 16V ALUMINUM
C2,3,12,16	CA08	4	100uF - 10/50% 16V ALUMINUM
1	B079	1	POWER/SWITCHER PCB, OXL 55N096 REV. E
P1	AC123	1	CAB, RIB 14 PIN, 3.25", OXIMETER
P2	AC42	1	CAB, RIB 20 PIN, 3", OM5/OXI

REV.	DESCRIPTION	BY	DATE
C	PER ECN NO. 3355M		10/20/92
B	PER ECN #2677M		12/11/90
A	PER ECN #2592M		10/8/90

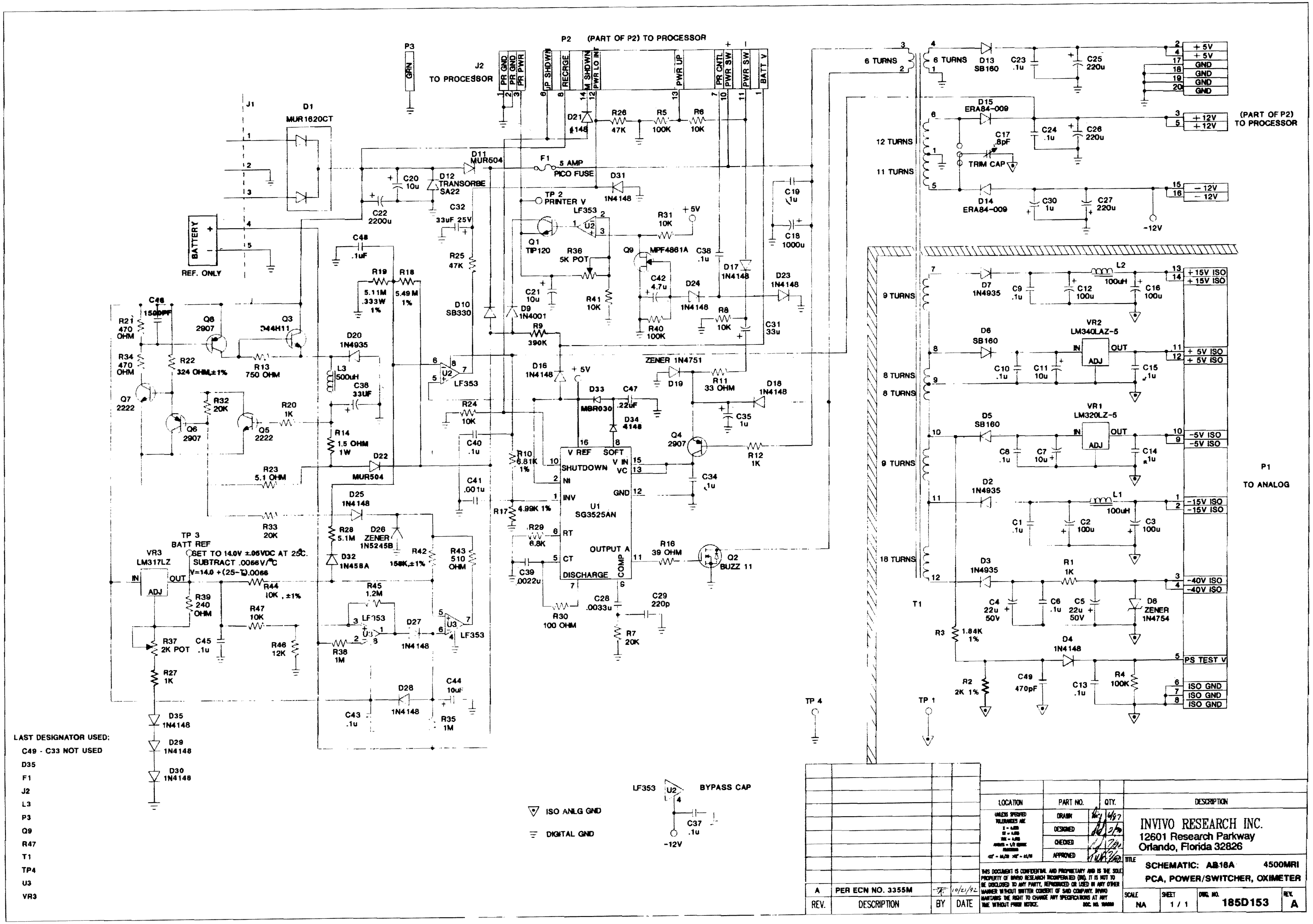
UNLESS SPECIFIED TOLERANCES ARE

DRAWN		2/88
DESIGNED		2/90
CHECKED		2/90
APPROVED		

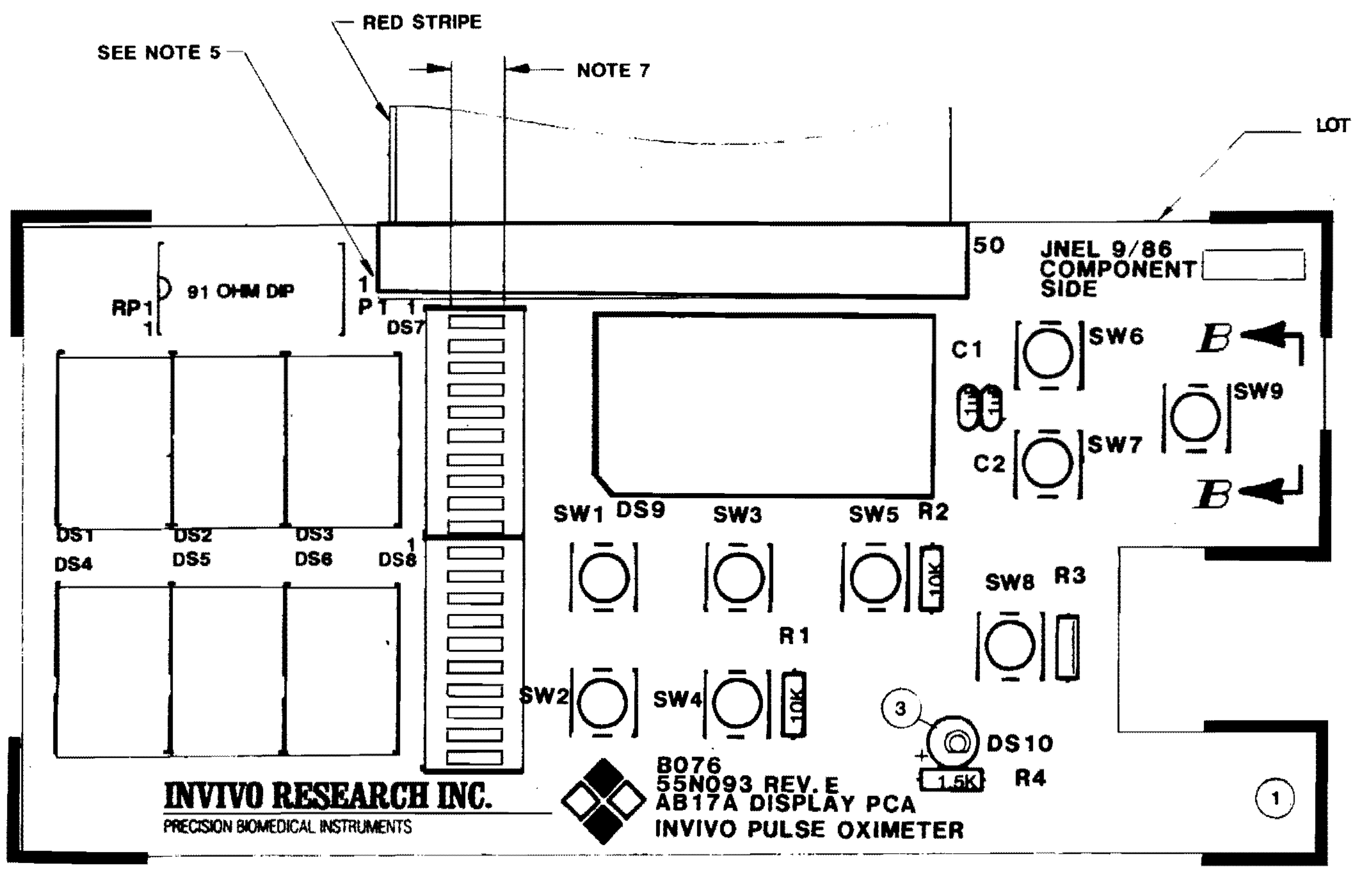
INVIVO RESEARCH INC.
12601 Research Parkway
Orlando, Florida 32826

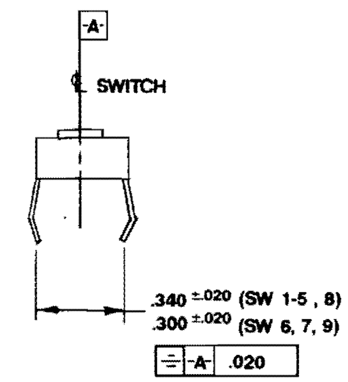
TITLE ASSEMBLY: AB18A
PCA, POWER SWITCHER,
OXIMETER 4500MRI

SCALE	SHEET	DWG. NO.	REV.
2:1	1/1	194D554	C



P2 (PART OF P2) TO PROCESSOR
J2 TO PROCESSOR
P3 GRN
PR GND
PR GND
PR PWR
UP SHDWN
RECRGE
M SHDWN
PWR LO INT
PWR UP
PR CNTL
PWR SW
PWR SW
BATT V
J1
D1 MUR1620CT
BATTERY
REF. ONLY
F1 5 AMP PICO FUSE
D11 MUR504
D12 TRANSORBE SA22
TP 2 PRINTER V
Q1 TIP120
Q9 MPF4861A
U1 SG3525AN
V REF
SOFT
SHUTDOWN
V IN
VC
NI
INV
GND
RT
CT
OUTPUT A
DISCHARGE
COMP
Q2 BUZZ 11
TP 3 BATT REF
SET TO 14.0V ±.05VDC AT 25C.
SUBTRACT .0066V/°C
V=14.0 +(25-T).0066
VR3 LM317LZ
IN
OUT
ADJ
6 TURNS
12 TURNS
11 TURNS
9 TURNS
8 TURNS
18 TURNS
T1
TRIM CAP
(PART OF P2) TO PROCESSOR
+5V
GND
+12V
-12V
+15V ISO
+ 5V ISO
-5V ISO
-15V ISO
-40V ISO
PS TEST V
ISO GND
P1 TO ANALOG
VR2 LM340LAZ-5
VR1 LM320LZ-5
TP 4
TP 1
LF353 U2 BYPASS CAP
ISO ANLG GND
DIGITAL GND
LAST DESIGNATOR USED:
C49 - C33 NOT USED
D35
F1
J2
L3
P3
Q9
R47
T1
TP4
U3
VR3
A PER ECN NO. 3355M 10/21/92
REV. DESCRIPTION BY DATE
LOCATION
PART NO.
QTY.
DESCRIPTION
DRAWN
DESIGNED
CHECKED
APPROVED
INVIVO RESEARCH INC.
12601 Research Parkway
Orlando, Florida 32826
TITLE
SCHEMATIC: AB18A 4500MRI
PCA, POWER/SWITCHER, OXIMETER
SCALE NA
SHEET 1 / 1
DWG. NO. 185D153
REV. A





VIEW B-B

(9 X SIZE)

ROTATED 90 DEGREES CW

NOTE: 7 SEGMENT DISPLAYS (DS1-6) CAN HAVE A TOLERANCE OF .015" DIFFERENCE IN HEIGHT AND STILL MAINTAIN SUITABLE DISTANCE FROM FRONT PANEL OVERLAY.

1. INSTALL DS1-DS6 WITH PART NUMBER TOWARDS TOP OF BOARD. INSTALL DS7 & DS8 WITH PART NUMBER TOWARDS LEFT SIDE OF BOARD WITH ONE EACH HI23 (2) ON EACH CORNER PIN, FLUSH WITH TOPS OF DS1-DS6 AND PARALLEL WITH TOP SURFACE OF PC BOARD WITHIN .015".
3 INSTALL DS10 USING SPACER(3).
4- TO PREVENT DAMAGE TO DISPLAYS AND SWITCHES, CLEAN BOARD WITH ALCOHOL OR DEGREASER ONLY.
5. CLIP PINS SHORT NEXT TO SOLDER JOINT ON P1 CONNECTOR.
6. BEFORE INSTALLING SW1-9, CAREFULLY BEND LEADS TO DIMENSIONS SHOWN IN VIEW B-B. NOTE ORIENTATION! LOCATION TOLERANCES AFTER INSTALLATION IS ±.020 FROM ℄ OF SWITCH TO THEORETICAL ℄ OF MOUNTING HOLES IN ANY DIRECTION.
7. LIGHTED RECTANGULAR SEGMENTS OF DS7 & DS8 TO BE IN LINE WITHIN .010

LOCATION	PART NO.	QTY.	DESCRIPTION
2	HI23	8	INSULATOR, BEAD, GLASS
3	HS13	1	SPACER .187 X #4 CL4003
R3	W019	1"	24 GAGE #299 SOFT DRAWN BUSS
SW1-9	S017	9	SWITCH, ALPS KHH10902 (SEE NOTE 6)
R4	R089	1	RES, 1.5K .25W 5% CF
R1 2	R002	2	RES, 10K .25W 5% CF
RP1	RD40	1	RES, DIP 91 OHM 8 PSTN CF
DS10	DL19	1	LED, RED HLMP-1340
DS7 8	DL06	2	BAR LED, RED HDSP-4830
DS9	DL05	1	HP CUSTOM DISPLAY
DS1-6	DL02	6	DISPLAY, 7 SEGMENT HDSP-5551
C1 2	CC12	2	.1uF 20% 50V Z5U CERAMIC
1	B076	1	DISPLAY PCB, OXIMETER 55N093-E
P1	AC115	1	CAB RIBBON, 50 PIN, 3.75", OXIMETER

REV.	DESCRIPTION	BY	DATE
P	PER ECN #3198	[illegible]	4/92
N	PER ECN #3110M	[illegible]	1/31/92
M	PER ECN NO. 2894	[illegible]	[illegible]
L	PER ECN #2296	[illegible]	3/90
K	PER ECN #2257	[illegible]	3/2/90
J	PER ECN #1815	[illegible]	4/21/89
H	PER ECN #1549	[illegible]	11/30/88
G	ECN # 1469	SR	10'88
F	ECN # 1422	[illegible]	9/12/88
E	ECN #1380	[illegible]	8/19/88
D	ECN #1092M	[illegible]	[illegible]
C	ECN #1022	[illegible]	9/87
B	ECN #983	ED	8/87
A	ECN #941 M	GA	7/87

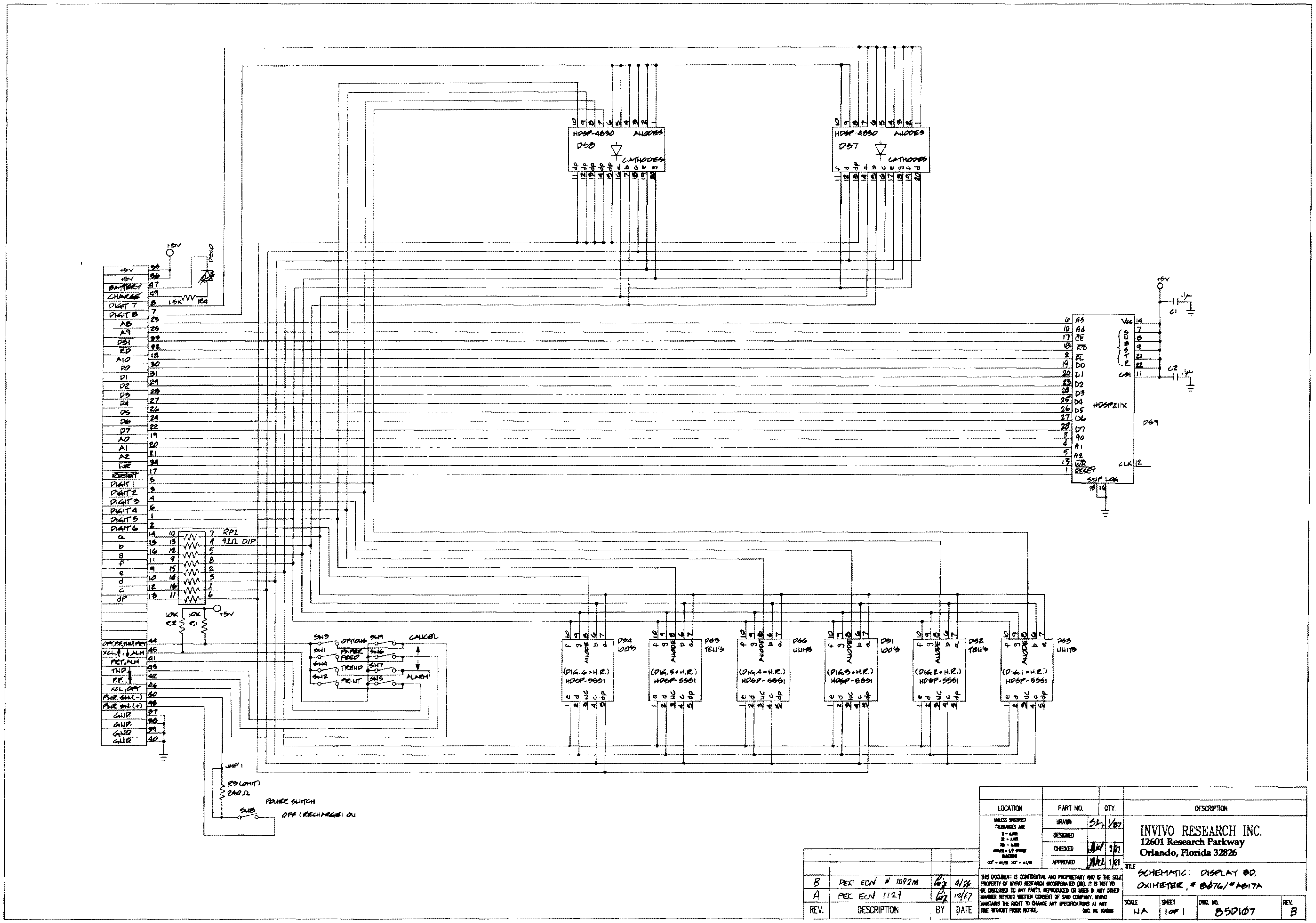
UNLESS SPECIFIED TOLERANCES ARE
X = ±.030
XX = ±.005
XXX = ±.005
ANGLES = 1/2 DEGREE
FRACTIONS
<12" = ±1/32 >12" = ±1/16

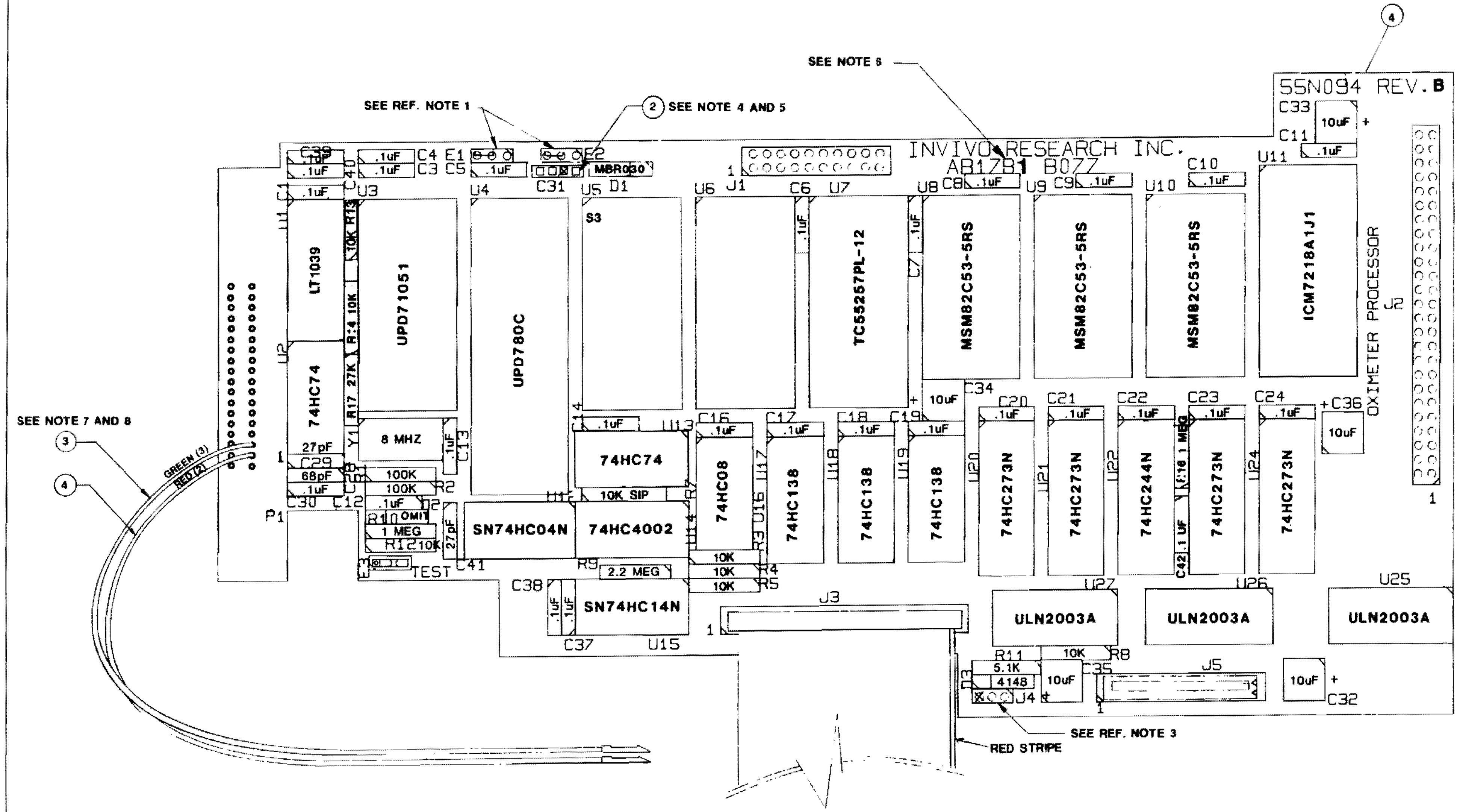
DRAWN	[illegible]	1/87
DESIGNED	[illegible]	3/87
CHECKED	[illegible]	6/87
APPROVED	[illegible]	6/87

INVIVO RESEARCH INC.
12601 Research Parkway
Orlando, Florida 32826

TITLE
#AB17A DISPLAY PCA, OXIMETER

SCALE	SHEET	DWG. NO.	REV.
2/1	1/1	94C346	P


HDSP-4830
ANODES
CATHODES
DS8
DS7
HDSP2111X
DS9
RP1
912 DIP
OPTIONS
PAPER FEED
TREND
PRINT
CANCEL
ALARM
POWER SWITCH
OFF (RECHARGE) ON
JMP1
(DIG.6=H.R.)
(DIG.5=H.R.)
(DIG.4=H.R.)
(DIG.3=H.R.)
(DIG.2=H.R.)
(DIG.1=H.R.)
HDSP-5551
LOCATION
PART NO.
QTY.
DESCRIPTION
DRAWN
DESIGNED
CHECKED
APPROVED
INVIVO RESEARCH INC.
12601 Research Parkway
Orlando, Florida 32826
TITLE
SCHEMATIC: DISPLAY BD, OXIMETER, # 8076/#AB17A
B PER ECN # 1092M 4/84
A PER ECN 1129 12/87
REV. DESCRIPTION BY DATE
THIS DOCUMENT IS CONFIDENTIAL AND PROPRIETARY AND IS THE SOLE PROPERTY OF INVIVO RESEARCH INCORPORATED (IRI). IT IS NOT TO BE DISCLOSED TO ANY PARTY, REPRODUCED OR USED IN ANY OTHER MANNER WITHOUT WRITTEN CONSENT OF SAID COMPANY. INVIVO MAINTAINS THE RIGHT TO CHANGE ANY SPECIFICATIONS AT ANY TIME WITHOUT PRIOR NOTICE.
SCALE NA
SHEET 1 OF 1
DWG. NO. 85D107
REV. B



4	AW140	1	WIRE, PROCESSOR TO PWR/SAT PWR. INT.(RED)
3	AW141	1	WIRE, PROCESSOR TO PWR/SAT PWR. INT.(GRN)
2	PA47	1	HEADER, UNSHRD, SR, RA, (.10)
4	AB17B	1	PCA, PROCESSOR, OXIMETER

LIST OF REF. PART NO.s

LOCATION	PART NO.	QTY.	DESCRIPTION
R17	R059	1	RES, 27K 5% .25W CF
P1	PA81	1	CONN, DB25 RA 745397-1
D1	D008	1	DIODE, SCHOTTKY, MBR030
S3	P001	1	28 PIN ICN286S4T
R7	RS02	1	RES, 10K SIP 8 PSTN CF
Y1	XC10	1	CRYSTAL 8.00 MHZ
E3	S021	1	SW., SLIDE INCA-2
R10 16	R128	2	RES, 1 MEG .25W 5% CF
R9	R125	1	RES, 2.2 MEG .25W 5% CF
E1 E2 U22-J3	W019	8"	24 GAGE #299 SOFT DRAWN BUSS
R11	R003	1	RES, 5.1K .25W 5% CF
R3-5 8 12 13 14	R002	7	RES, 10K .25W 5% CF
R1 2	R000	2	RES, 100K .25W 5% CF
U25-27	Q025	3	ULN2003A DARLINGTON ARRAY
J3	AC116	1	CABLE, RIBBON, 34 PIN, 3.75"
J2	PA116	1	STIX, 50 PIN 1/2" 2-87543-5
J5	PA115	1	CONN, FLEX CABLE, 23 PIN 39-513234
J4	PA08	1	STIX, 3 PIN 1/2" 103321-3
J1	PA02A	1	STIX, 20 PIN DUAL 1-87530
U3	I004	1	UPD71051 USART PCI CMOS
U4	IN23	1	UPD780C PROCESSOR
U5		1	SEE NOTE 3
U7	IM07	1	TC55257PL-12 32K X 8 BIT 120ns
U1	IC72	1	LT1039
U16	IC53	1	74HC08 QUAD 2 INPUT AND GATE
U20 21 23 24	IC49	4	74HC273N OCTAL "D" FLIP FLOP
U22	IC45	1	74HC244N OCTAL TRI STATE BUFFER
U12	IC33	1	SN74HC04N HEX INVERTER
U15	IC30	1	SN74HC14N HEX SCHMITT INVERTER
U8-10	IC17	3	MSM82C53-5RS PRGMBLE INT TIMER
U14	IC16	1	74HC4002 DUAL 4 INPUT NOR GATE
U11	IC15	1	ICM7218A1J1 8 DIGIT LED DRIVER
U17-19	IC06	3	74HC138 DECODER
U2 13	IC05	2	74HC74 DUAL "D" FLIP FLOP
D3	D000	1	SIGNAL 1N4148
C32-36	CT13	5	10uF 20% 35V TANTALUM
C29 41	CC00	2	27pF 20% 50V Z5U CERAMIC
C28	CC09	1	68pF 10% 50V Z5U CERAMIC
C1,3-14,16-24, 30,31,37-40,42	CC12	29	.1uF 20% 50V Z5U CERAMIC
1	B077	1	PROCESSOR PCB, OXIMETER 55N094 REV. B

AB17B1 ASSEMBLY NOTES

4. REMOVE CAPACITOR (CC12) FROM C31 LOCATION AND DISCARD.
5. INSTALL HEADER (2) (PA47) AT C31 LOCATION, CUTTING THE TWO CENTER PINS ON SOLDER SIDE FLUSH WITH HEADER. PLACE HEADER WITH THE PINS TOWARD NEAREST EDGE OF BOARD AND BEND UPWARD APPROX. 45°, CUTTING THE PIN AS INDICATED BY THE "X".
6. USING INDELIBLE WHITE INK OR PAINT, PLACE A "1" AFTER THE EXISTING NUMBER MAKING "AB17B1", AS SHOWN.
7. REMOVE DB36 CONNECTOR (PA81) FROM P1 LOCATION AND DISCARD.
8. INSTALL WIRE ASSY (3) (AW141) AND (4) (AW140) AT P1 LOCATION, RED WIRE TO PIN 2 AND GREEN WIRE TO PIN 3, AS SHOWN.

(REF.) AB17B ASSEMBLY NOTES

1. JUMPER DESIGNATED PINS AT E1 AND E2 WITH 1" BUSS WIRE AT EACH.
2. C2 AND R15 DESIGNATORS NOT USED.
3. J4, PIN 3 (AS INDICATED BY "X") TO BE CUT AT BOARD ASSEMBLY LEVEL AND INSPECTED AT QC LEVEL TO VERIFY.

LAST DESIGNATORS USED: U25, R17, C42, P1, J5, Y1, D3, E2

REV.	DESCRIPTION	BY	DATE
B	PER ECN NO. 3383M	[illegible]	10/92
A	PER ECN #2511	[illegible]	8/90

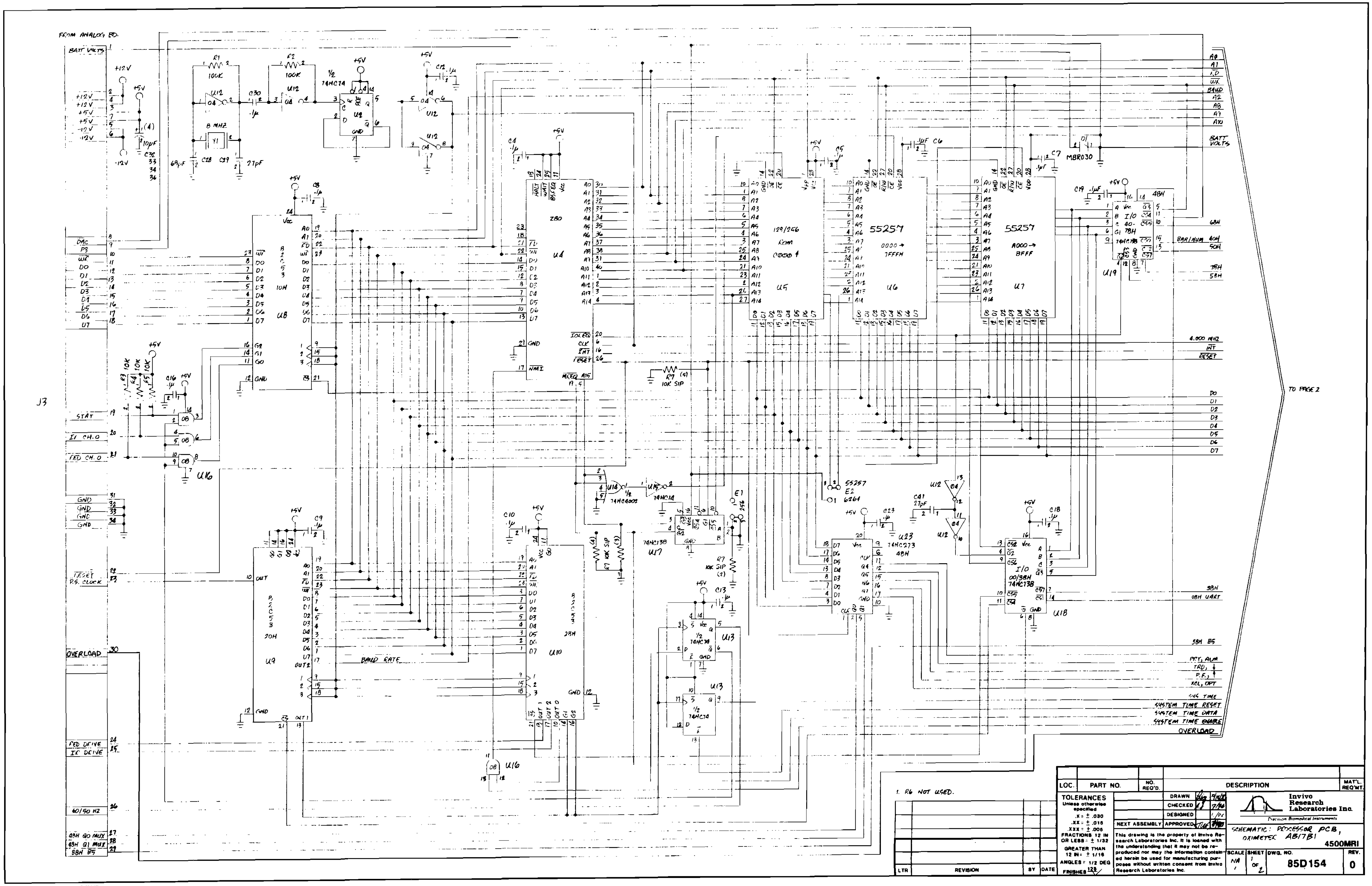
UNLESS SPECIFIED TOLERANCES ARE [illegible]

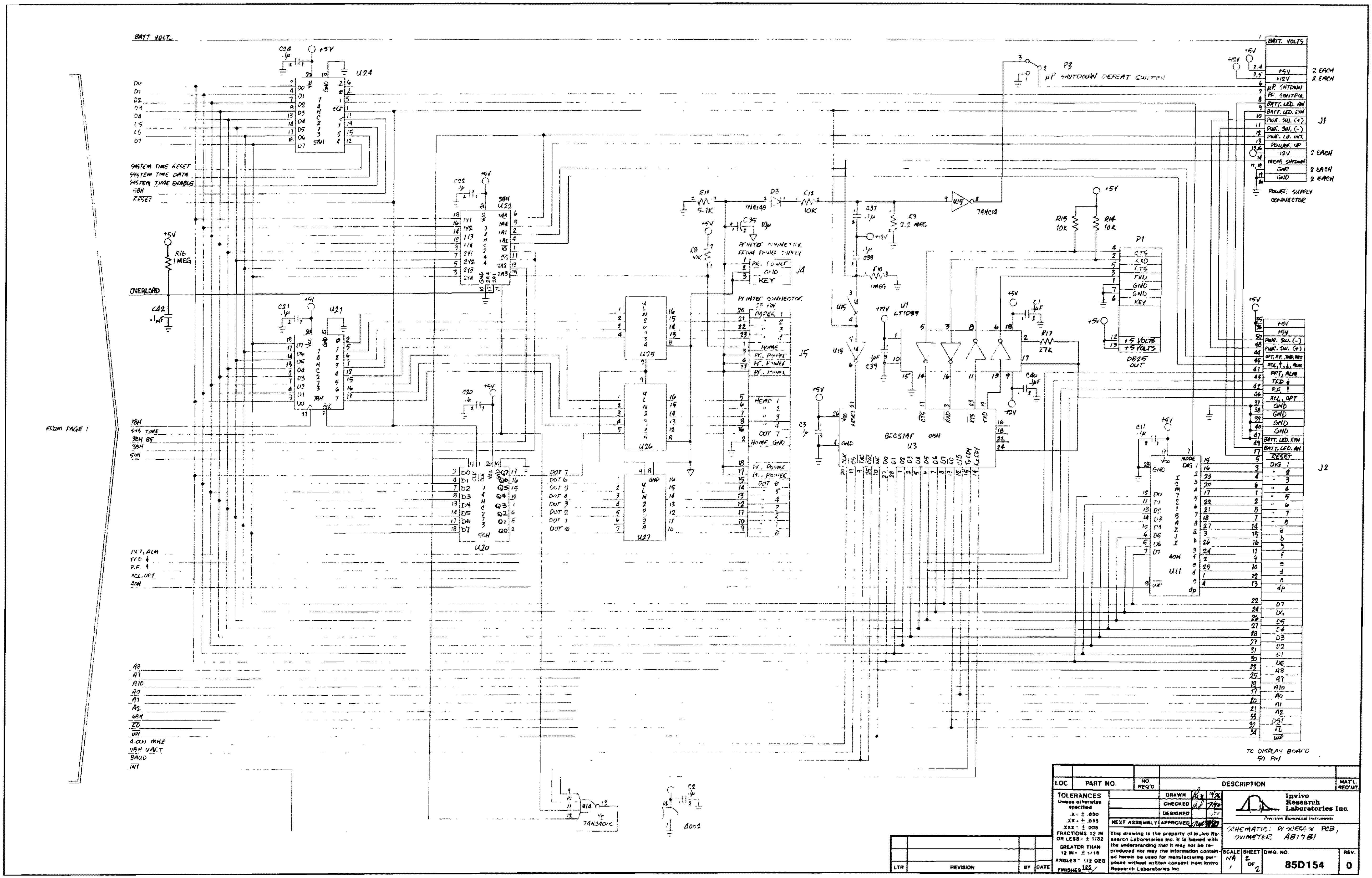
DRAWN	[illegible]	[illegible]
DESIGNED	[illegible]	[illegible]
CHECKED	[illegible]	7/90
APPROVED	[illegible]	7/90

INVIVO RESEARCH INC.
12601 Research Parkway
Orlando, Florida 32826

TITLE
ASSEMBLY: AB17B1
PCA, PROCESSOR, OXIMETER, 4500 MRI

SCALE 2/1 | SHEET 1/1 | DWG. NO. 194D555 | REV. B


FROM ANALOG BD.
J3
U4
Z80
U5
U6
U7
55257
U8
U9
U10
U13
U16
U17
U18
U19
U23
TO PAGE 2
1. R6 NOT USED.
TOLERANCES
Invivo Research Laboratories Inc.
SCHEMATIC: PROCESSOR PCB, OXIMETER AB17B1
4500MRI
85D154



FROM PAGE 1
TO DISPLAY BOARD
50 PIN
POWER SUPPLY CONNECTOR
μP SHUTDOWN DEFEAT SWITCH
J1
J2
J4
J5
P1
P3
DB25 OUT
OVERLOAD
BATT VOLT.
SYSTEM TIME RESET
SYSTEM TIME DATA
SYSTEM TIME ENABLE
RESET
TOLERANCES
Unless otherwise specified
DESCRIPTION
DRAWN
CHECKED
DESIGNED
APPROVED
NEXT ASSEMBLY
Invivo Research Laboratories Inc.
SCHEMATIC: PROCESSOR PCB, OXIMETER AB17B1
SCALE
SHEET 2 OF 2
DWG. NO.
85D154
REV.
0
LTR
REVISION
BY
DATE
This drawing is the property of Invivo Research Laboratories Inc. It is loaned with the understanding that it may not be reproduced nor may the information contained herein be used for manufacturing purposes without written consent from Invivo Research Laboratories Inc.

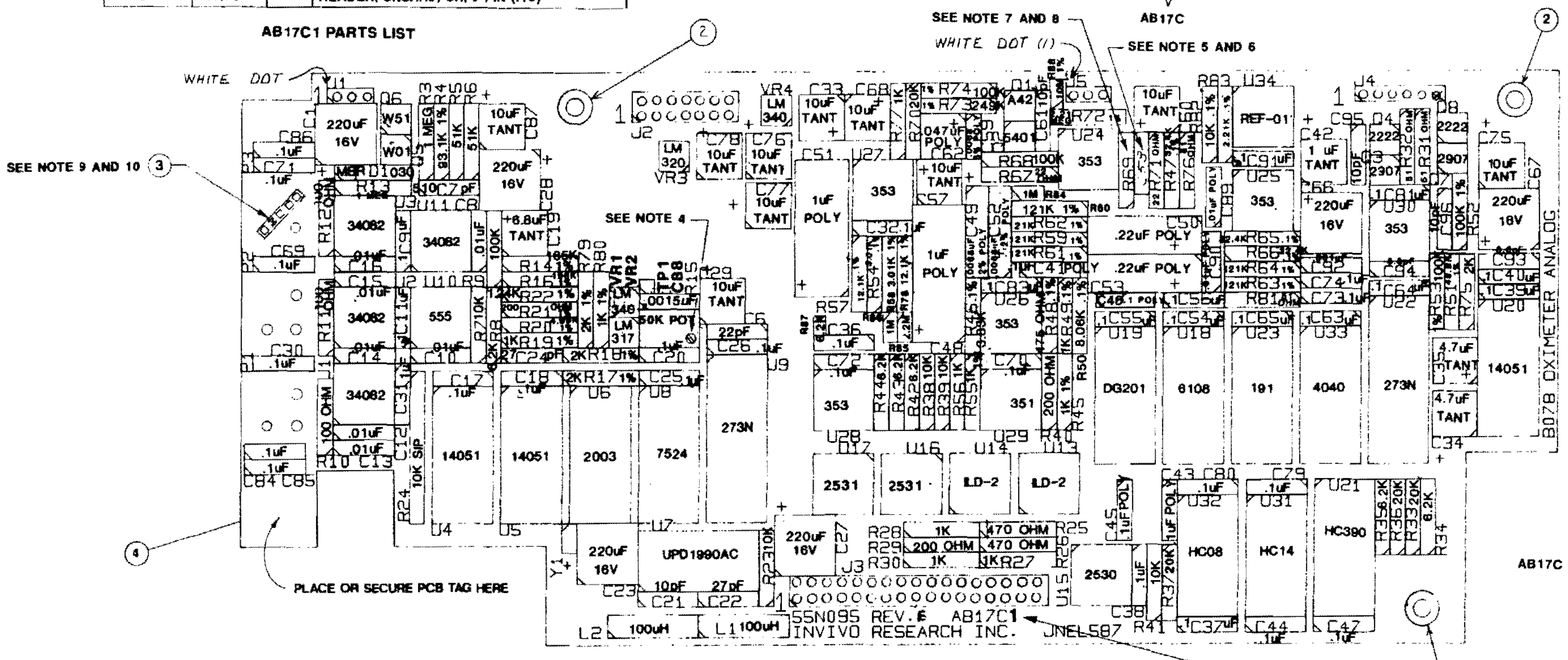
LOCATION	PART NO.	QTY.	DESCRIPTION
R73	RF108	1	RES , 249K , 1% .5W MF
C34, 35	CT14	2	CAP, 4.7uF 20% 16V TANTALUM
R85	R125	1	RES, 2.2 MEG .25W 5% CF
VR2	IR41	1	LM340LAZ-5 POSITIVE REGULATOR
Y1	XC03	1	CRYSTAL, 32.768 KHZ
L1 2	T008	2	COIL, MOLDED 100UH ±10%
R31 32 76 81	R152	4	RES,51 OHM .25W 5% CF
R3 13 84 86	R128	4	RES,1 MEG .25W 5% CF
R10-12	R046	3	RES,100 OHM .25W 5% CF
C42	CT09	1	1uF 20% 35V TANTALUM
R8, 34, 35, 42, 43, 44, & R87	R028	7	RES,8.2K .25W 5% CF
R5 6	R023	2	RES,51K .25W 5% CF
R88	RF110	1	RES , 10 MEG , 1% .5W MF
R70 33,36,37	R022	4	RES,20K .25W 5% CF
R75	R017	1	RES,2K .25W 5% CF
R67 71	R009	2	RES,22 OHM .25W 5% CF
R29 40	R008	2	RES,200 OHM .25W 5% CF
R69	R004	1	RES, 470K .25W 5% CF
R7 23 38 39 41	R002	4	RES,10K .25W 5% CF
28 30 27 56 77	R001	5	RES,1K .25W 5% CF
R9 68	R000	2	RES,100K .25W 5% CF
R24	RS06	1	RES,10K SIP 10 PISTON CF
R15	RP83A	1	RES,50K POT 68WR50K
R50	RF97	1	RES,8.06K .125W .1% MF
R49	RF96	1	RES,1K .125W .1% MF
R48	RF95	1	RES,475 OHM .125W .1% MF
R82	RF94	1	RES,10K .125W .1% MF
U1-3 11	IL43	4	MC34082P DUAL OP-AMP 14V SWING
R46	RF92	1	RES,3.83K .125W 1% MF
R 25 26	R033	2	RES , 470 OHM .25W 5% CF
R16	RF80	1	RES,196K .125W 1% MF
2	HS35	3	SPACER, .625 X #6 KFE-143-20
R47 65 66	RF56	3	RES,32.4K .125W .1% MF
R51	RF48	1	RES,49.9K .125W 1% MF
R4	RF42	1	RES,93.1K .125W 1% MF
R20	RF20	1	RES,4.99K .125W 1% MF
R22	RF19	1	RES,1.24K .125W 1% MF
R21	RF18	1	RES,200 OHM 1% .125W MF
R19 45 55 80	RF17	4	RES,1K .125W 1% MF
R57 78	RF106	2	RES,12.1K .125W .1% MF
R83	RF105	1	RES,2.21K .125W .1% MF
R54 58	RF104	2	RES,3.01K .125W .1% MF
R72	RF103	1	RES,2.21 MEG .25W 1% MF
R14	RF08	1	RES, 165K .125W 1% MF
R59-64	RF06	6	RES, 121K .125W 1% MF
R52 53 , 74	RF02	3	RES,100K .125W 1% MF
U16, U17	IL51	2	OPTO COUPLER, DUAL HCPL2531
R17 18 79	RF01	3	RES,2K .125W 1% MF
Q6	Q038	1	MPSW51 PNP SILICON
Q5	Q037	1	MPSW01 NPN SILICON
Q2	Q033	1	2N5401 PNP
U6	Q025	1	ULN2003A DARLINGTON ARRAY
Q1	Q021	1	MPSA42 NPN HIGH VOLTAGE
Q3 7	Q001	2	MPS2907A PNP
Q4 8	Q005	2	MPS2222A NPN
J2	PA127	1	STIX,DUAL,14 PIN 87543-7
P1-3	PA120	3	PHONE JACK 1/8"
J3	PA119	1	STIX,DUAL,34 PIN 1-87543-7
J1 5	PA08	2	STIX,3 PIN,3 1/2" 103321-3
J4	PA01	1	STIX,6 PIN,1/2" 103321-6
TP1	PA00	1	STIX,1 PIN 1/2" 103321-1
U34	IR47	1	REF-01 VOLT REF/PRECISION 10%
VR1	IR09	1	LM317LZ POSITIVE REGULATOR
VR3	IR06	1	LM320LZ-15 NEGATIVE REGULATOR
VR4	IR05	1	LM340LAZ-15 POSITIVE REGULATOR
U15	IL41	1	HCPL2530 DUAL OPTO COUPLER
U13 14	IL24	2	ILD-2 QUAD CHANNEL OPTO
U23	IL19	1	TL191N BI-MOS SWITCH
U10	IL12	1	NE555 TIMER (MC1455)
U29	IL07	1	LF351N OP AMP
U 24-28 30	IL06	6	LF353N DUAL OP AMP
U33	IC60	1	74HC4040 12 BIT BINARY COUNTER
U32	IC53	1	74HC08 QUAD 2 INPUT AND
U8	IC51	1	AD7524KN 8 BIT DAC
U9 22	IC49	2	74HC273N OCTAL D FLIP FLOP
U18	IC35	1	IH6108CPE 8 CHANNEL ANALOG
U7	IC31	1	UPD1990AC REAL TIME INVERTER CLOCK
U31	IC30	1	74HC14N HEX SCHMITT INVERTER
U19	IC22	1	DG201 QUAD SPST ANALOG
U21	IC13	1	74HC390 DUAL BCD COUNTER
U4 5 20	IC00	3	MC14051BCP MULTIPLEXER
D1	D008	1	SCHOTTKY MBR030 ERA81-00
C29 33 57 60 66 75-78 87	CT13	10	10uF 20% 35V TANTALUM
C62	CP23	1	.047uF 5% 50V POLYESTER
C19	CT01	1	6.8uF 20% 16V TANTALUM
C59	CP29	1	.0068uF 5% 50V POLYESTER
C48 51	CP28	2	1uF 2% 100V POLYESTER
C50 53	CP25	2	.22uF 2% 50V POLYESTER
C88	CC39	1	.0015uF 10% 50V CERAMIC
C41 43 45 46	CP08	4	.1uF 5% 100V POLYESTER
C49 52	CP18	2	.0068uF 2% 100V POLYESTER
C89 90	CP07	2	.01uF 2% 100V POLYESTER
C8	CC01	1	22pF 10% 50V Z5U CERAMIC
C7	CC38	1	510pF 5% COG CERAMIC
C93 94	CC15	2	3.3pF +/-.5pF 200V CERAMIC
C9 11 17 18 20 25 26 30-32 36-40 44 47 54-56 63-65 69-74 79-81 83-86 91	CC12	37	.1uF 20% 50V Z5U CERAMIC
C58	CC08	1	100pF 10% 50V Z5U CERAMIC
C92	CC05	1	.001uF 10% 50V XR7 CERAMIC
C6 10 12-16	CC04	7	.01uF 10% 50V X7R CERAMIC
C21 61 95 96	CC03	4	10pF 10% 50V Z5U CERAMIC
C22 24	CC00	2	27pF 20% 50V Z5U CERAMIC
C1 23 27 28 66 67	CA07	6	220uF -10%+50% 16V ALUMINUM
1	B078	1	ANALOG PCB, OXIMETER 55N095E

LIST OF REF. PART NO.s

AB17C

LOCATION	PART NO.	QTY.	DESCRIPTION
4	AB17C	1	PCA, ANALOG, OXIMETER
R69	RF75	1	RES, 1 MEG 1% .125W MF
C58	CC07	1	CAP, 47pF 10% 50V X7R CERAMIC
3	PA06	1	HEADER, UNSHRD, SR, 5 PIN (.10)

AB17C1 PARTS LIST



(REF.) AB17C ASSEMBLY NOTES

1. NOTE: PRESS SPACERS (2) INTO BOARD DURING FINAL BOARD ASSEMBLY ON COMPONENT SIDE.
2. RESISTORS IN THE FOLLOWING LOCATIONS MUST BE STUFFED SO THAT THE TEMPERATURE CO-EFFICIENT IS VISIBLE. (RN55C) R54,R57,R58,R78,R82, & R83.
3. CUT PIN J4-6 (AS INDICATED BY "X") ARE TO BE CUT AT BOARD ASSEMBLY LEVEL AND INSPECTED AT QC LEVEL TO VERIFY.
4. INSTALL POT, R15 WITH ITS ADJUSTING SCREW AWAY FROM VR2, LM317 AS SHOWN.

AB17C1 ASSEMBLY NOTES

5. REMOVE CAPACITOR (CC08) AT C58 LOCATION AND DISCARD.
6. INSTALL CAPACITOR P/N CC07 AT C58 LOCATION.
7. REMOVE RESISTOR (R004) AT R69 LOCATION AND DISCARD.
8. INSTALL RESISTOR P/N RF75 AT R69 LOCATION.
9. REMOVE PHONE JACKS (PA120) AT P1, P2, & P3 LOCATIONS AND DISCARD.
10. INSTALL HEADER (3) (PA06) AT P3 LOCATION, POSITIONED AS SHOWN, CUTTING THE THREE CENTER PINS ON UNDERSIDE, FLUSH WITH HEADER. ON THE TOP SIDE, CUT THE PIN AS INDICATED BY THE "X".
11. USING INDELIBLE WHITE INK OR PAINT, PLACE A "1" AFTER THE EXISTING NUMBER MAKING "AB17C1" AS SHOWN.

REV.	DESCRIPTION	BY	DATE
A	PER ECN #2513	JT	8/94

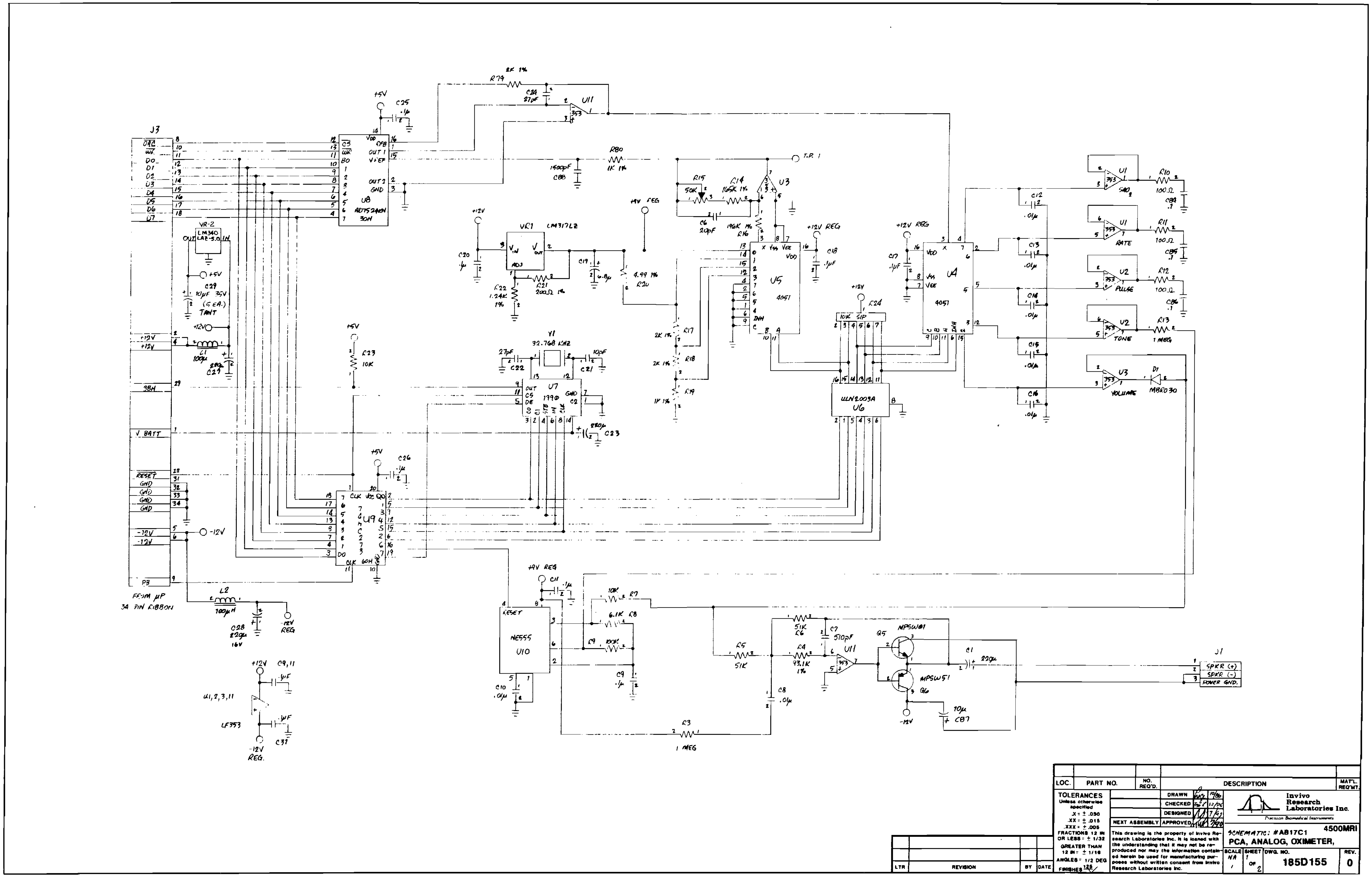
UNLESS SPECIFIED TOLERANCES ARE	DRAWN	GA	6/87
	DESIGNED		7/87
	CHECKED		
	APPROVED		7/87

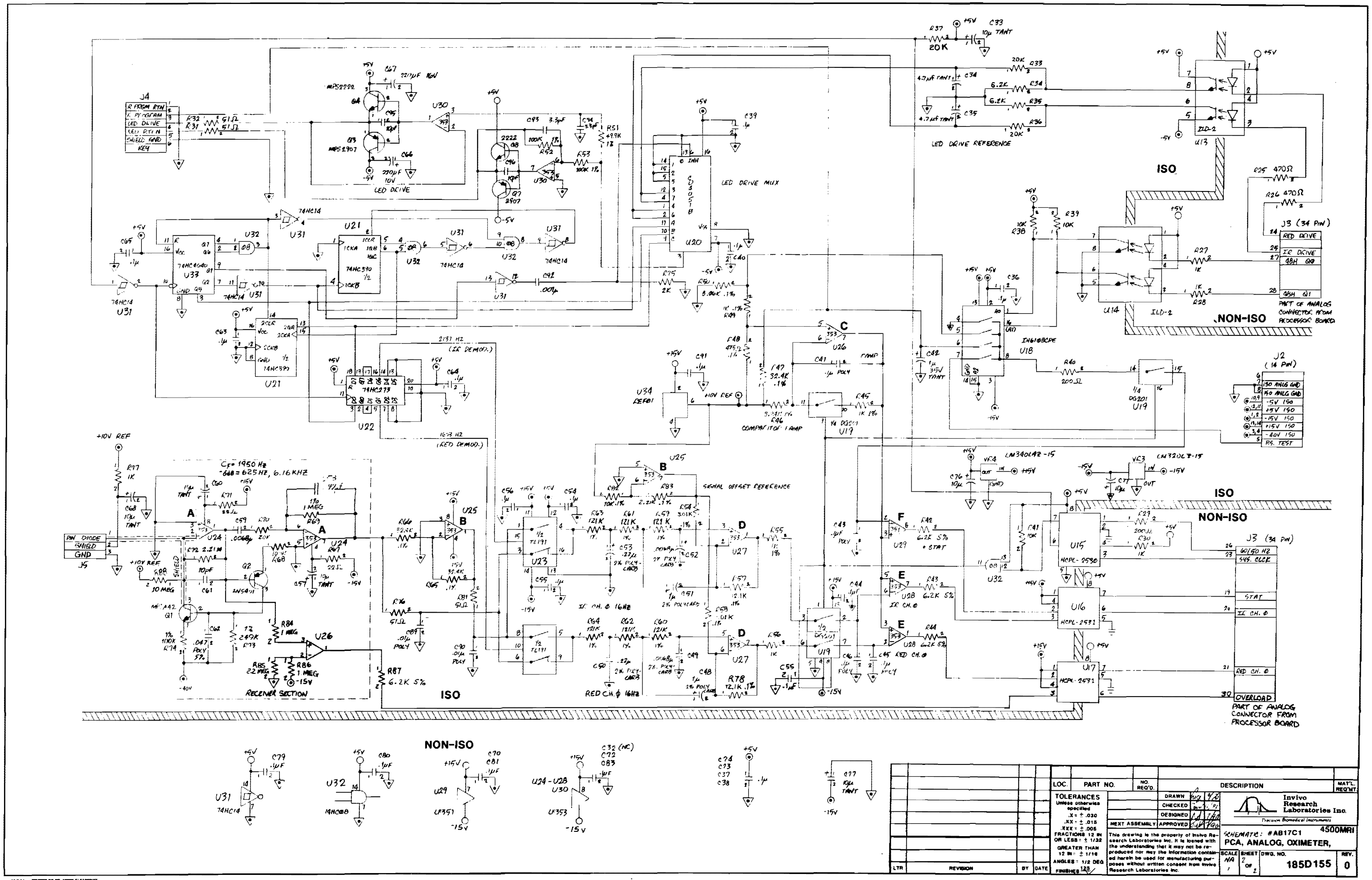
INVIVO RESEARCH INC.
12601 Research Parkway
Orlando, Florida 32826

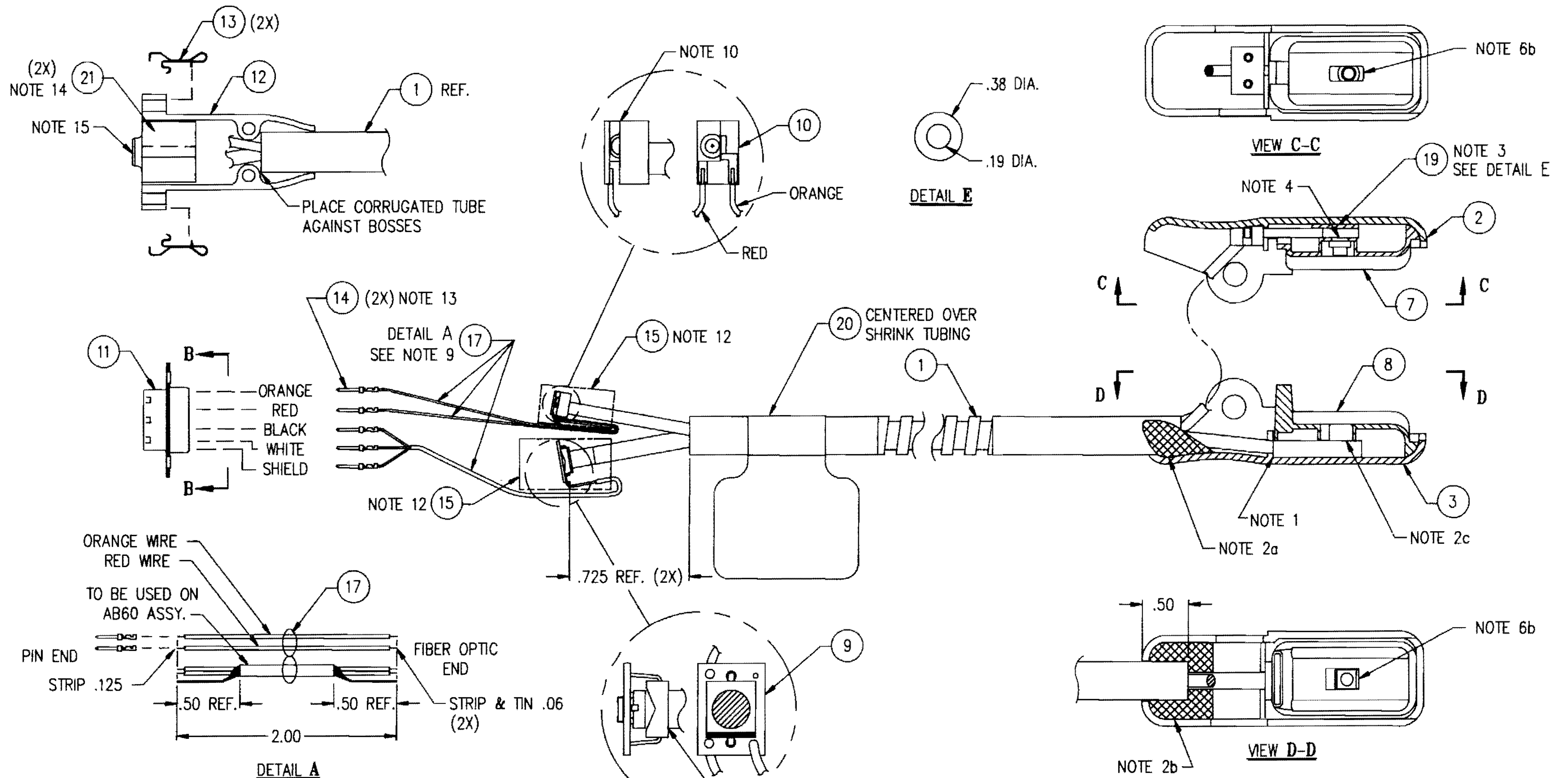
THIS DOCUMENT IS CONFIDENTIAL AND PROPRIETARY AND IS THE SOLE PROPERTY OF INVIVO RESEARCH INCORPORATED (IRI). IT IS NOT TO BE DISCLOSED TO ANY PARTY, REPRODUCED OR USED IN ANY OTHER MANNER WITHOUT WRITTEN CONSENT OF SAID COMPANY. INVIVO MAINTAINS THE RIGHT TO CHANGE ANY SPECIFICATIONS AT ANY TIME WITHOUT PRIOR NOTICE.

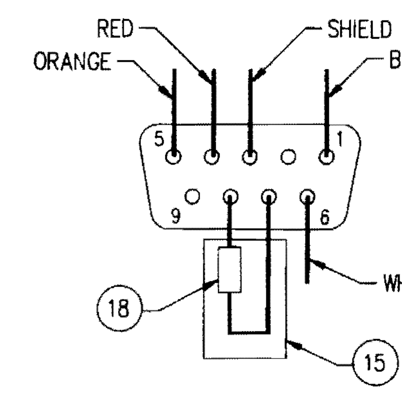
TITLE ASSEMBLY: AB17C1
PCA, ANALOG, OXIMETER, 4500MRI

SCALE	SHEET	DWG. NO.	REV.
2 1	1 1	194D556	A


J3
FROM μP
34 PIN RIBBON
ADT524KN
LM340 LAZ-5.0
LM317LZ
32.768 KHZ
1990
NE555
ULN2003A
4051
MPSW01
MPSW51
MBR030
LF353
SPKR (+)
SPKR (-)
POWER GND.
LOC.
PART NO.
NO. REQ'D.
DESCRIPTION
MAT'L. REQ'MT.
TOLERANCES
DRAWN
CHECKED
DESIGNED
NEXT ASSEMBLY
APPROVED
Invivo Research Laboratories Inc.
SCHEMATIC: #AB17C1
4500MRI
PCA, ANALOG, OXIMETER,
This drawing is the property of Invivo Research Laboratories Inc. It is loaned with the understanding that it may not be reproduced nor may the information contained herein be used for manufacturing purposes without written consent from Invivo Research Laboratories Inc.
SCALE
SHEET
DWG. NO.
REV.
185D155
0
LTR
REVISION
BY
DATE


LED DRIVE
LED DRIVE MUX
LED DRIVE REFERENCE
ISO
NON-ISO
J4
J3 (34 PIN)
J2 (14 PIN)
PART OF ANALOG CONNECTOR FROM PROCESSOR BOARD
COMPARATOR AMP
SIGNAL OFFSET REFERENCE
RECEIVER SECTION
IR CH. Ø 16HZ
RED CH. Ø 16HZ
LM340LAZ-15
LM320LZ-15
TOLERANCES
DRAWN
CHECKED
DESIGNED
APPROVED
NEXT ASSEMBLY
Invivo Research Laboratories Inc.
SCHEMATIC: #AB17C1
4500MRI
PCA, ANALOG, OXIMETER,
185D155
REV.
0





VIEW B-B

WIRING VIEW

PIN NO.	WIRE
1	BLACK
3	SHIELD
4	RED
5	ORANGE
6	WHITE
7	RM12
8	

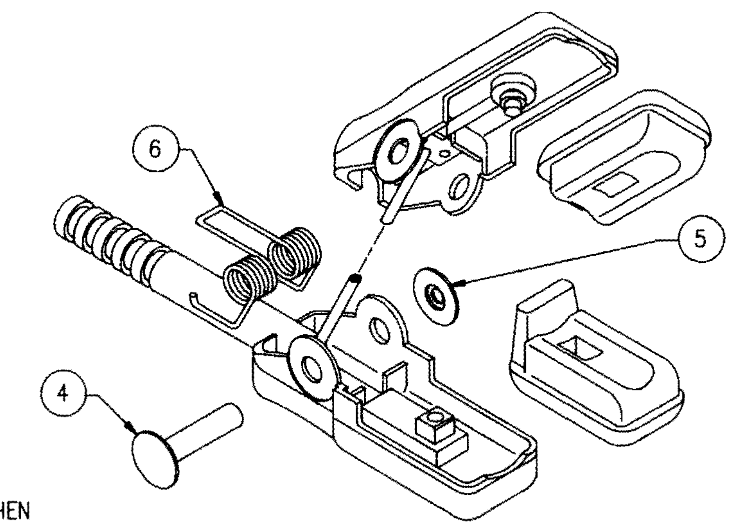
NOTES

FINGER PROBE END

1. PLACE FIBER OPTIC BLOCK AGAINST PLASTIC STOP AND GLUE IN PLACE WITH ADHESIVE, M052 & ACTIVATOR, M019
2a. PLACE ADHESIVE, M052 & ACTIVATOR, M019 AROUND LIP TO SECURE CABLE, THEN PLACE ASSEMBLY IN FIXTURE WITH FRONT OF FINGER PROBE AT 30° ANGLE
b. FILL REAR AREA OF FINGER PROBE WITH "EPO-TEK 302", M106. ALLOW TO DRY.
c. REMOVE BOTTOM OF RECESS IN PILLOW, HM15J (ITEM 8) AND SECURE PILLOW TO BOTTOM HALF, HM15B3 (ITEM 3) USING RTV, M008A
3. PLACE TAPE, M000C (ITEM 20) AS SHOWN IN DETAIL E. PLACE IN TOP HALF, HM15A3 (ITEM 2) CENTERED AS SHOWN
4. PUNCH .10 DIA. HOLE IN BOTTOM CENTER OF RECESS OF PILLOW, HM15H (ITEM 7) AND INSERT SENSOR BLOCK THRU HOLE AS SHOWN
5. SECURE SENSOR BLOCK TO TOP HALF, HM15A3 (ITEM 2) WITH ADHESIVE, M052 & ACTIVATOR, M019 LOCATING ON PINS IN FINGER PROBE
6a. SECURE PILLOW, HM15H (ITEM 7) USING RTV, M008A
b. FILL PILLOW CUPS WITH AQUARIUM SEALANT, M065, AND SMOOTH SURFACE
7. ASSEMBLE TORSION SPRING, HM15F (ITEM 6) AND TOP & BOTTOM ASSEMBLIES BY INSERTING PIN, HM15C2 (ITEM 4) THRU FINGER PROBE HOLES
8. SECURE ASSEMBLY BY ATTACHING RETAINER TOP, HM15D2 (ITEM 5) TO RETAINER PIN WITH ADHESIVE, M052 & ACTIVATOR, M019

CONNECTOR END

9. REMOVE OUTER JACKET FROM CABLE, W055 (ITEM 17). PREPARE AS SHOWN IN DETAIL A. CRIMP & SOLDER PINS TO "PIN END" THEN SOLDER WIRES (FIBER OPTIC END) TO LED ASSEMBLY (ITEM 10) AS SHOWN.
10. ALIGN REFLECTOR WITH FIBER OPTIC USE "EPO-TEK 302", M106 TO SECURE REFLECTOR TO FIBER OPTIC BLOCK
11. ALIGN CENTERED AS SHOWN. USE "EPO-TEK 302", M106 TO SECURE PHOTODIODE TO FIBER OPTIC BLOCK
12. COVER BOTH FIBER OPTIC ENDS WITH SHRINK TUBING, WT02
13. INSERT PINS INTO CONNECTOR, PA217, PER VIEW B-B
14. PLACE TWO (2) .50 LONG STRIPS OF KAPTON TAPE, M088A, ON TOP & BOTTOM BACKSHELLS AS SHOWN
15. ASSEMBLE BACKSHELL, PC03 (ITEM 12) AND SPRING LATCHES, H080 (ITEMS 13) TO CONNECTOR AND CABLE



ITEM / REF. DES.	PART NO.	QTY.	DESCRIPTION
21	M088A	2.00	TAPE,KAPTON,.004 THK.,1/2" WD,RL
20	L828	1	CABLE TAG, ID/SER., DUAL FBR.OPT
19	M000C	.38	TAPE,CLSD.CL.FM,SS,.12THK.x1"W
18	RM12	1	RES, 42.2K, >.05W, 1%, MF
17	W055	2.00	CABLE,SHD,2x2 COND,32 GA, SILCN
16	WT04	1.00	HEAT SHRINK, 3/32" I.D. BLACK
15	WT02	1.00	HEAT SHRINK, 1/4" I.D. BLACK
14	PA77	2	CONTACT, PIN, CRIMP, 24-20 AWG
13	H080	2	SPRING LATCH, "D" CONNECTOR
12	PC03	1	CLAMP, CAB, DB9, SHLD, ST EXT
11	PA76	1	CONN,DB9,SNAP-IN CNTCT,MTL.SHL
10	DL23	1	LED ASSY,DUAL FIB-OPT,FNGR SNSR
9	AB60	1	PCA, MR F.O. SAT SNSR., OPTO III
8	HM15J	1	PILLOW, SILICON, PROBE w\STOP
7	HM15H	1	PILLOW, SILICON, PROBE
6	HM15F	1	FINGER PROBE, TORSION SPRING
5	HM15D2	1	FINGER PROBE, RETAINER TOP
4	HM15C2	1	FINGER PROBE, RETAINER PIN
3	HM15B3	1	FING. PROBE,BOT. HALF,BEIGE,MOD.
2	HM15A3	1	FING. PROBE,TOP HALF,BEIGE,MOD.
1	AC27A	1	CAB., DUAL FIB-OPT, FNGR SNSR

REV.	DESCRIPTION	BY	DATE
A	PER ECN NO. 3549	CHY	6/1/93

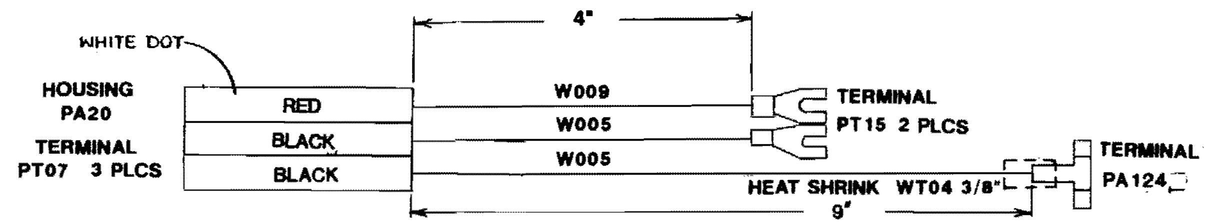
UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: .XX = ±.01, .XXX = ±.005, ANGLES = ±1/2°

DRAWN CHY 2/93; DESIGNED RS 1/93; CHECKED; APPROVED

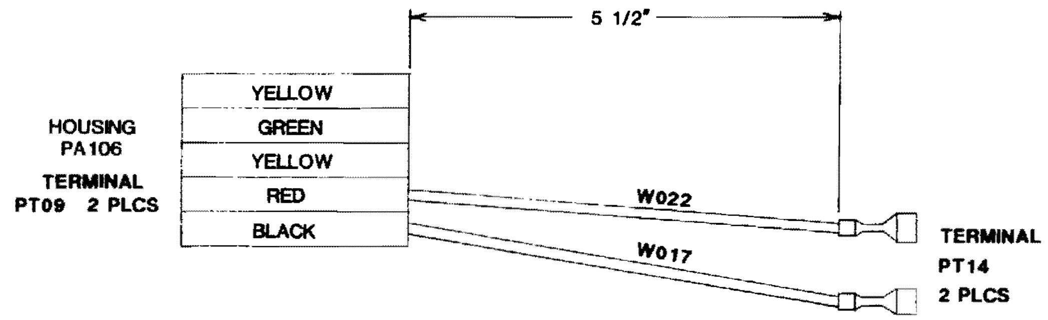
INVIVO RESEARCH INC.
12601 RESEARCH PARKWAY
ORLANDO, FLORIDA 32826

TITLE CAB ASSY: #9397
DUAL FBR.OPT, FNGR SNSR

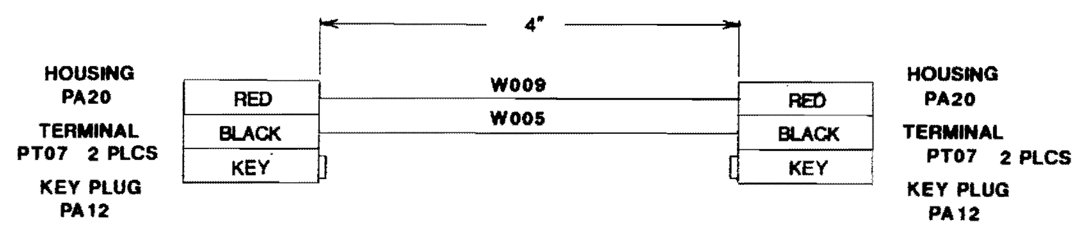
SCALE NONE | SHEET 1 OF 1 | DWG. NO. 197B427 | REV. A



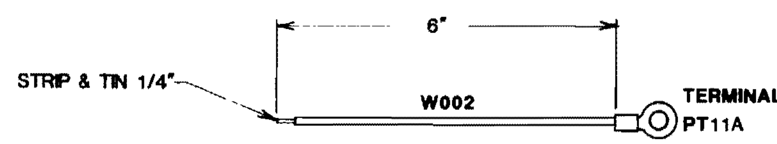
AC135 - SPEAKER CABLE , OXIMETER
(22 GAGE WIRE)



AC136 - TRANSFORMER CABLE , OXIMETER
(18 GAGE WIRE)



AC141 - PRINTER POWER CABLE , OXIMETER
(22 GAGE WIRE)



AW110 - GREEN / YELLOW , OXIMETER
(16 GAGE WIRE)

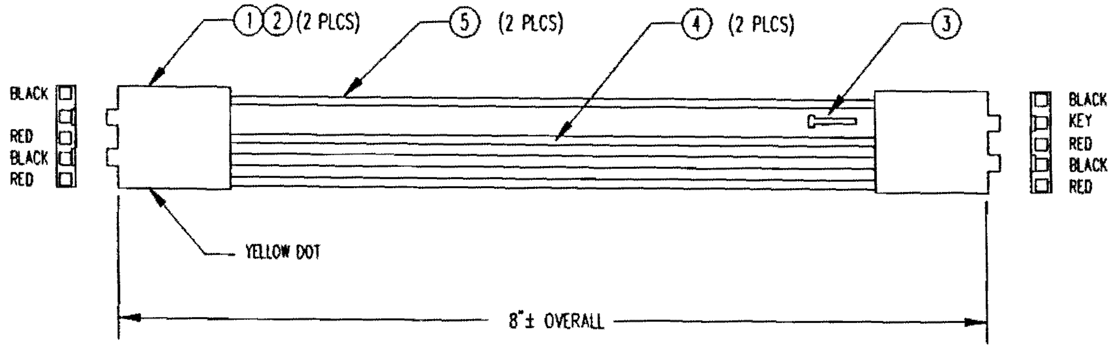
REFER TO DWG. # 97B216 FOR
CRIMPING INSTRUCTIONS .

REV.	DESCRIPTION	BY	DATE
E	PER ECN #2823	[illegible]	5/91
D	PER ECN #1216	[illegible]	3/31/88
C	PER ECN# 1010M	ED	7/87
B	Per ECN # 973	ED	9/87
A	ECN #968	GA	8/87

LOCATION	PART NO.	QTY.	DESCRIPTION
UNLESS SPECIFIED TOLERANCES ARE	DRAWN	ED 7/87	INVIVO RESEARCH INC. 12601 Research Parkway Orlando, Florida 32826
	DESIGNED	ED 7/87	
	CHECKED	[illegible] 7/87	
	APPROVED	[illegible] 7/87	TITLE ASSEMBLY CABLES FOR OXIMETER

THIS DOCUMENT IS CONFIDENTIAL AND PROPRIETARY AND IS THE SOLE PROPERTY OF INVIVO RESEARCH INCORPORATED (IRI). IT IS NOT TO BE DISCLOSED TO ANY PARTY, REPRODUCED OR USED IN ANY OTHER MANNER WITHOUT WRITTEN CONSENT OF SAID COMPANY. INVIVO MAINTAINS THE RIGHT TO CHANGE ANY SPECIFICATIONS AT ANY TIME WITHOUT PRIOR NOTICE.

SCALE	SHEET	DWG. NO.	REV.
N/A	1 of 1	59C084	E



NOTES

1. USING YELLOW INDELIBLE INK OR PAINT, PUT A YELLOW DOT ON SIDE OF CONNECTOR AT PIN 1 AS SHOWN.

ITEM / REF. DES.	PART NO.	QTY.	DESCRIPTION
5	W017	15"	WIRE, 18 GAGE 19 X 30 BLACK UL-1430
4	W022	15"	WIRE, 18 GAGE 19 X 30 RED UL-1430
3	PA25	1	KEY PLUG (.156)
2	PT09	8	TERMINAL, RECPT, REEL, 102100-6
1	PA106	2	HOUSING, SR, 5 PIN (.156)

REV.	DESCRIPTION	BY	DATE
B	PER ECN NO. 3355M	SR	10/92
A	PER ECN NO. 2532	SLP	8/90

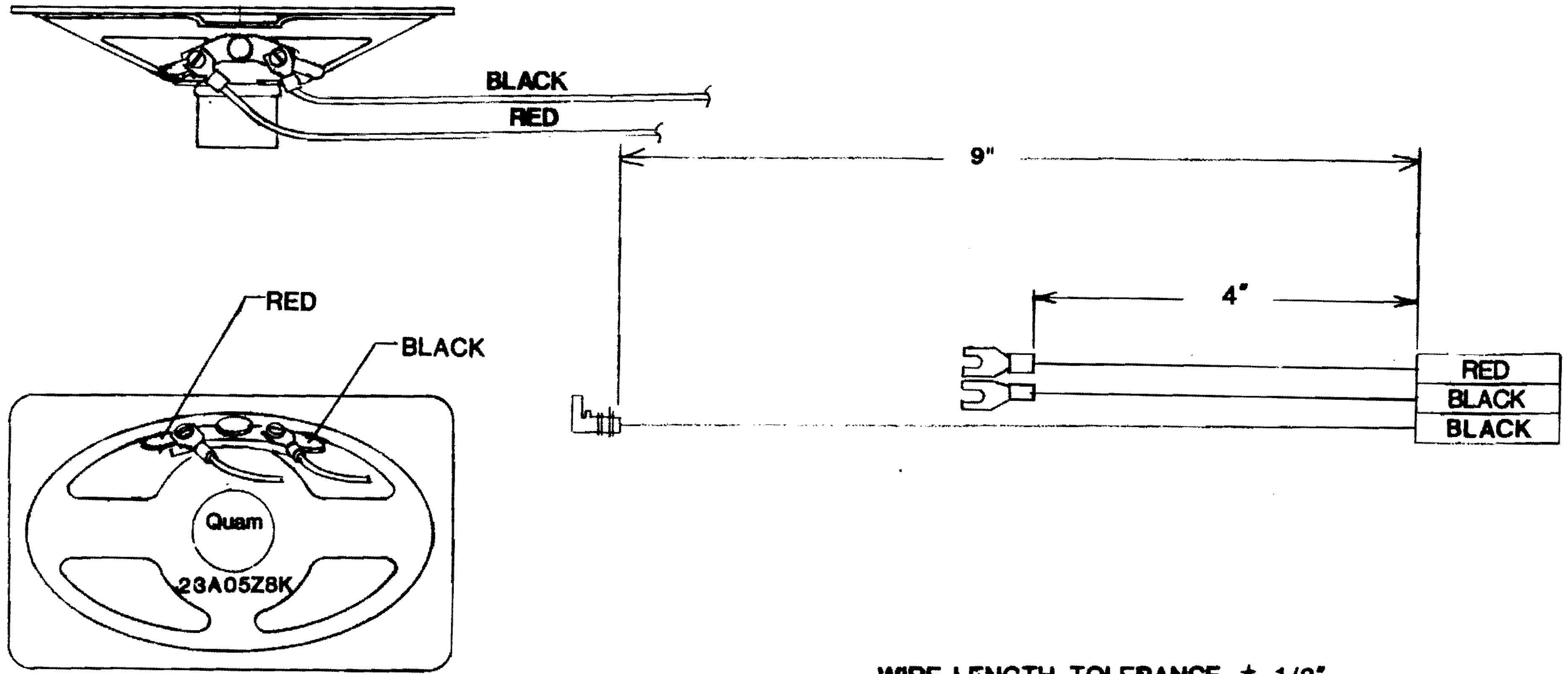
UNLESS SPECIFIED TOLERANCES ARE
.XX = ±
.XXX = ±
ANGLES = ±

DRAWN	SLP	7/90
DESIGNED	SLP	7/90
CHECKED	[illegible]	[illegible]
APPROVED	[illegible]	[illegible]

INVIVO RESEARCH INC
12601 Research Parkway
Orlando, Florida 32826

TITLE
CABLE ASSEMBLY: AC216
4500 MRI POWER INTERCONNECT

SCALE	SHEET	DWG. NO.	REV.
1:1	1 OF 1	C59B133	B



WIRE LENGTH TOLERANCE ± 1/2"

ATTACH AC135 TO SPEAKER SCREW TERMINALS AS SHOWN .
APPLY BLUE LOCTITE ON BACK SIDE OF SPEAKER SCREW

LOCATION	PART NO.	QTY.	DESCRIPTION
2	AC135	1	CAB SPEAKER, OXIMETER
1	X004	1	SPEAKER, 2" X 3" 1/2W 23A05Z8

REV.	DESCRIPTION	BY	DATE
D	PER ECN #1421	JF	9/88
C	PER ECN #1216	Pricy	3/2/88
B	PER ECN #973	ED	8/87
A	PER ECN # 931	ED	7/87

UNLESS SPECIFIED TOLERANCES ARE
X = ±.030
XX = ±.015
XXX = ±.005
ANGLES = 1/2 DEGREE
FRACTIONS
<2" = ±1/32 >12" = ±1/16

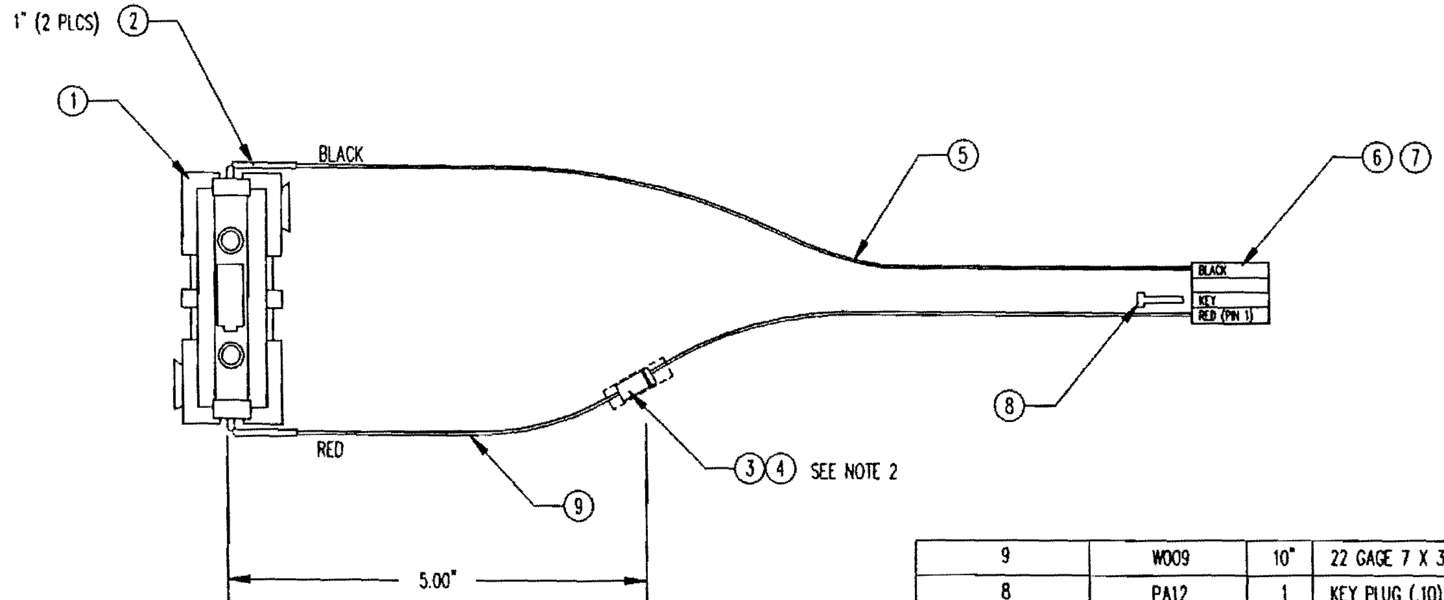
DRAWN	[illegible]	6/87
DESIGNED	[illegible]	6/87
CHECKED	[illegible]	7/87
APPROVED	[illegible]	7/87

INVIVO RESEARCH INC.
12601 Research Parkway
Orlando, Florida 32826

THIS DOCUMENT IS CONFIDENTIAL AND PROPRIETARY AND IS THE SOLE PROPERTY OF INVIVO RESEARCH INCORPERATED (IRI). IT IS NOT TO BE DISCLOSED TO ANY PARTY, REPRODUCED OR USED IN ANY OTHER MANNER WITHOUT WRITTEN CONSENT OF SAID COMPANY. INVIVO MANTAINS THE RIGHT TO CHANGE ANY SPECIFICATIONS AT ANY TIME WITHOUT PRIOR NOTICE. DOC. NO. 10A007

TITLE
#AS72 SPEAKER ASSEMBLY, OXIMETER

SCALE	SHEET	DWG. NO.	REV.
NA	1 / 1	04B367	D



ITEM / REF. DES.	PART NO.	QTY.	DESCRIPTION
9	W009	10"	22 GAGE 7 X 30 RED UL-1429
8	PA12	1	KEY PLUG (.10)
7	PT07	2	TERMINAL, LOCKING CLIP 87124-2
6	PA17	1	HOUSING, SR, 4 PIN (.10)
5	W005	10"	22 GAGE 7 X 30 BLACK UL-1429
4	D007	1	DIODE, SCHOTTKY, ERA84-009
3	WT11	1"	HEAT SHRINK, 1/4" I.D. CLEAR
2	WT04	2"	HEAT SHRINK, 3/32" I.D., BLACK
1	HB01	1	HOLDER, BATTERY 400-2802-01-00-20

NOTES:

1. ASSEMBLE BATTERY CLIP ONTO BATTERY HOLDER TOWARDS BLACK (NEGATIVE) SIDE.
2. PLACE DIODE 5" FROM BATTERY TERMINAL. ASSURE THAT DIODE POLARITY IS POSITIONED AS SHOWN. CUT LEADS 1/4" ON BOTH ENDS OF DIODE. USE J-HOOK TERMINATION WHEN ASSEMBLING WIRE TO DIODE.

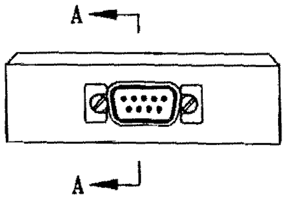
REV.	DESCRIPTION	BY	DATE
B	PER ECN #3382	SR	10/92
A	PER ECN #2543	SLP	8/90

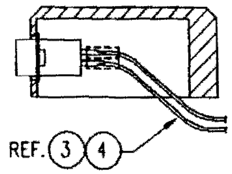
UNLESS SPECIFIED TOLERANCES ARE			
.XX = ±	DRAWN	SLP	7/90
.XXX = ±	DESIGNED	SLP	7/90
ANGLES = ±	CHECKED	[illegible]	10/92
	APPROVED	[illegible]	10/92

INVIVO RESEARCH INC
12601 Research Parkway
Orlando, Florida 32826

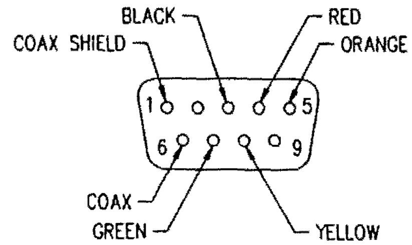
TITLE
ASSEMBLY: AS03A
UNIVERSAL BATTERY HOLDER

SCALE	SHEET	DWG. NO.	REV.
NONE	1 OF 1	C94B568	B



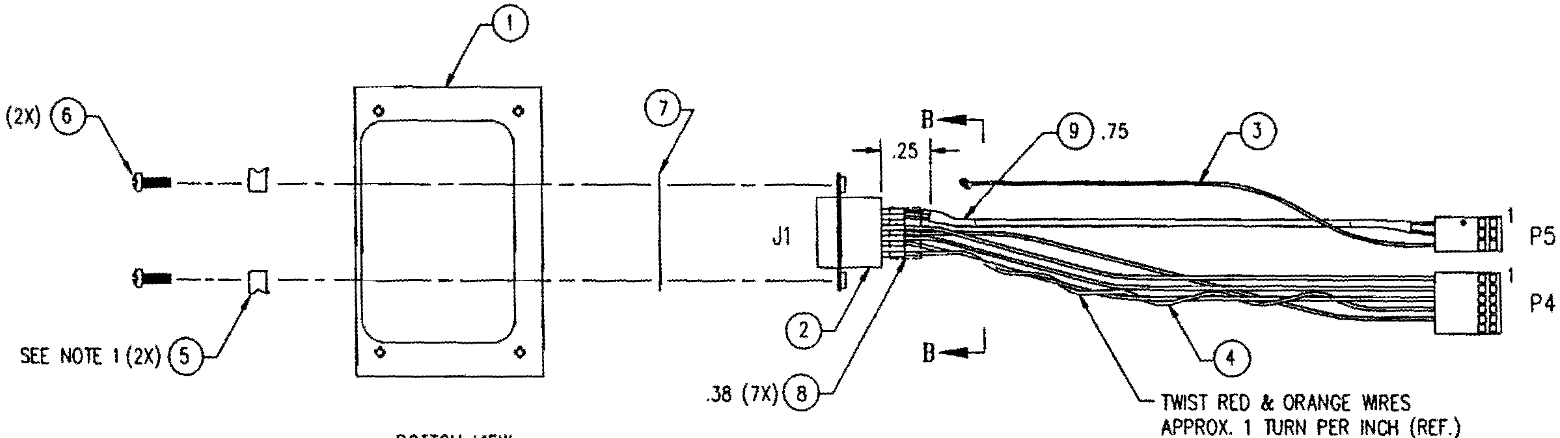


SECTION A-A



VIEW B-B
WIRING VIEW

J1 PIN NO.	P4 PIN NO.	P5 PIN NO.	WIRE COLOR
1	——	2	COAX SHIELD
2	——	——	——
3	5	——	BLACK
4	3	——	RED
5	4	——	ORANGE
6	——	1	COAX
7	1	——	GREEN
8	2	——	YELLOW
9	——	——	——
——	——	3	GREEN (GND LUG)
——	6	——	KEY



BOTTOM VIEW

NOTE
1. H079 (ITEM 5) IS SUPPLIED AS A KIT OF TWO (2) EACH

ITEM / REF. DES.	PART NO.	QTY.	DESCRIPTION
9	WT05	.75	HEAT SHRINK, 3/16 I.D., BLACK
8	WT04	2.62	HEAT SHRINK, 3/32 I.D., BLACK
7	PA202	1	GASKET, EMI/RFI, 9 PIN CONNECTOR
6	NS81	2	SCR, #4-40 x 6/16 LG. FIHMS-ZINC
5	H079	1	LATCH BLOCK, CONN, .090 PANEL
4	AC223A	1	CAB. ASSY, LED DRIVE, 4500 MRI, OXI
3	AC224	1	CAB. ASSY, COAX DRIVE, 4500 MRI, OXI
2	PA216	1	CONN, DB9 RCPTCL, SOLDERCUP, DE FLTR
1	HM23A	1	ADAPTER BOX, DL.FBR. OPTIC, MRI OX

REV.	DESCRIPTION	BY	DATE
C	PER ECN NO. 3562	CHY	6/10/93
B	PER ECN NO. 3526	CHY	6/4/93
A	PER ECN NO. 3536	SR	5/93

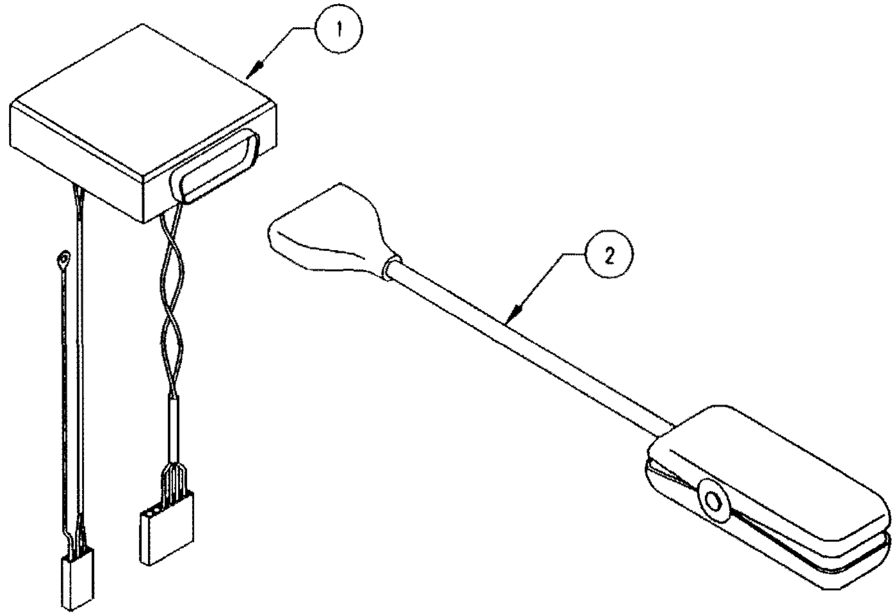
UNLESS OTHERWISE SPECIFIED TOLERANCES ARE
.XX = ±
.XXX = ±
ANGLES = ±

DRAWN	CHY	2/2/93
DESIGNED	GRB	1/93
CHECKED	[illegible]	6/93
APPROVED	[illegible]	6/93

INVIVO RESEARCH INC.
4420 METRIC DRIVE SUITE A
WINTER PARK, FLORIDA 32792

TITLE
SUB ASSEMBLY #AS127
JCT. BOX, MRI DUAL F.O.

SCALE	SHEET	DWG. NO.	REV.
NONE	1 OF 1	C94C624	C



	ITEM / REF. DES.	PART NO.	QTY.	DESCRIPTION
NOT SHOWN	5	M098	1	BOX, 11.25 x 8.75 x 5.00
NOT SHOWN	4	LL52	1	PROCEDURE, INSTL., 4500MRI/SFWR.
NOT SHOWN	3	AM35	1	PROM SET, OXIMETER, 4500MRI
	2	9397	1	CAB. ASSY, DUAL FIB. OPT, FNGR. SNSR.
	1	AS127	1	JCT. BOX SUBASSY. MRI DUAL F.O.

NOTES

1. DRAWING FOR AC206 BEFORE REDESIGN WAS C59D123, REV. C

REV.	DESCRIPTION	BY	DATE
A	PER ECN NO. 3543	CHY	5/19/93

UNLESS OTHERWISE SPECIFIED TOLERANCES ARE
.XX = ± ——
.XXX = ± ——
ANGLES = ± ——

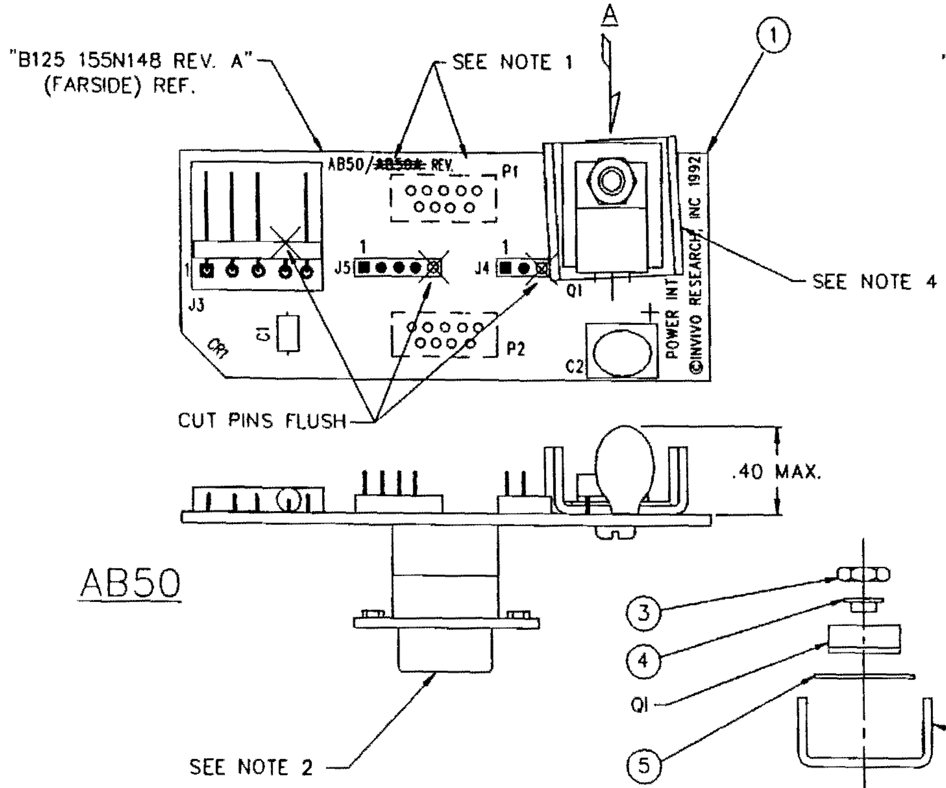
DRAWN	CHY	3/93
DESIGNED	GRB	3/93
CHECKED	gbl	5/93
APPROVED	TW	5/93

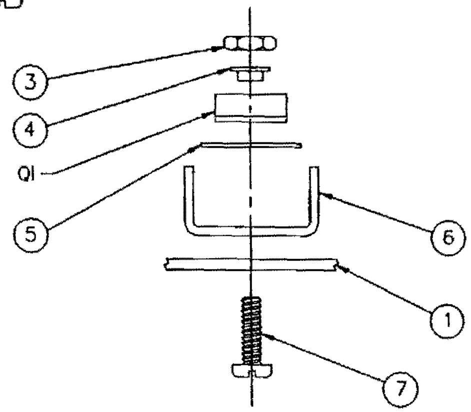
DWGS. WITH 'C' PREFIX ARE REDUCED CAD DWGS. - DO NOT SCALE !

INVIVO RESEARCH INC.
12601 RESEARCH PARKWAY
ORLANDO, FLORIDA 32826

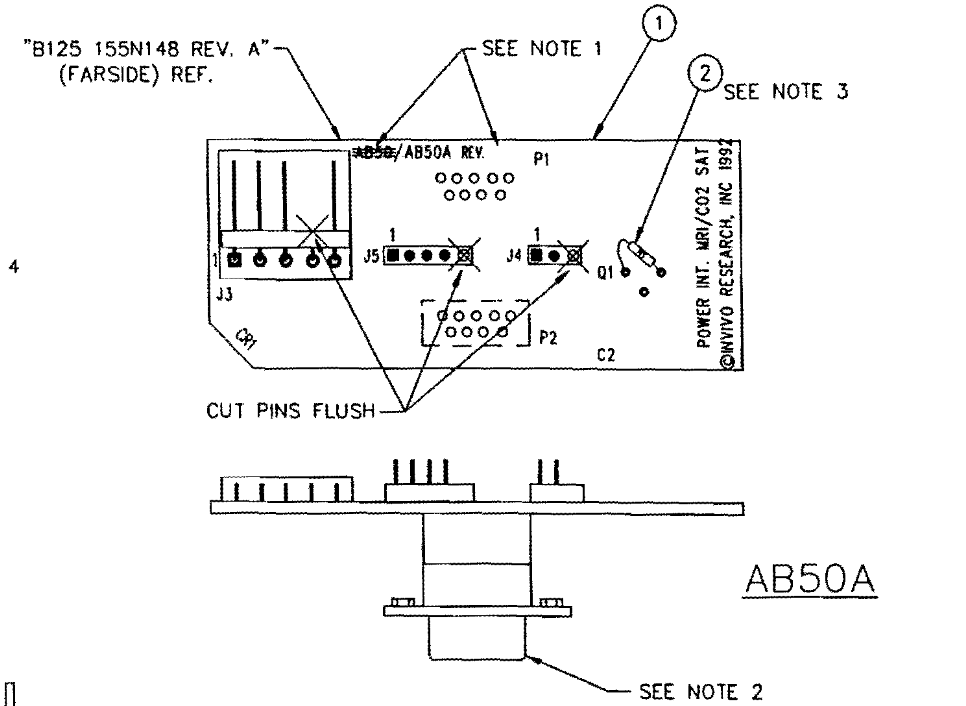
TITLE
PROC. & INSTR.: #AC206
CAB. ASSY., SNSR, MRI DUAL FIB. OPT

SCALE	SHEET	DWG. NO.	REV.
NONE	1 OF 1	C97B432	A





DETAIL A
ROTATED 180°



2	R010	1	RES, 2.7 OHM .25W 5% CF
J4	PA08	1	HEADER, UNSHR. SR, 3 PIN, (.10)
J5	PA06	1	HEADER, UNSHR. SR, 5 PIN, (.10)
J3	PA121	1	HEADER, UNSHR. SR, 5 PIN (.156)
P2	PA200	1	CONN, RCPT, DB9, RA, SLDRTAIL,DA
1	B125	1	PCB, MRI/CO2 SAT POWER INT.

AB50A MRI SAT PWR INT. (STAND ALONE)

7	NS26	1	#4-40 X 3/8 LG. PHMS, ZN
6	HQ02	1	HEAT SINK, LOW PRFL., TO5/220
5	HI01	1	INSULATOR, THERM. CONDUCTIVE
4	HI03	1	BUSHING, SHLDR., NYLON, .120 I.D.
3	N002	1	#4-40 HEX NUT, ZN
J4	PA08	1	HEADER, UNSHR. SR, 3 PIN, (.10)
J5	PA06	1	HEADER, UNSHR. SR, 5 PIN, (.10)
J3	PA121	1	HEADER, UNSHR. SR, 5 PIN (.156)
C2	CT16	1	CAP., 10uF, ±20%, 35V, TANT. RAD.
C1	CC12	1	CAP., .1uF, ±20%, 50V, Z5U, CER
Q1	IR12	1	REGULATOR, +15V LM7815CT
P1,P2	PA200	2	CONN, RCPT, DB9, RA, SLDRTAIL,DA
1	B125	1	PCB, MRI/CO2 SAT POWER INT.

AB50 MRI CO2 PWR INT.

LOCATION	PART NO.	QTY.	DESCRIPTION

NOTES:

1. WITH PERMANENT MARKER, CROSS OUT THE ASS'Y. NUMBER THAT IS NOT BEING BUILT, THEN ADD CURRENT ASS'Y. REV. LETTER
2. DB9 CONNECTORS P1 AND P2 ARE INSTALLED ON SOLDER SIDE
3. FOR AB50A VIEW ABOVE NOTE THAT THERE IS NO REF. DESIGNATOR SILKSCREENED ON THE BOARD FOR (R1) RESISTOR, ITEM 2 ON BOM. THIS RESISTOR IS TO BE INSTALLED ON COMPONENT SIDE, USING PADS 1 AND 3 (AS SHOWN) AT Q1 LOCATION
4. ROTATE HQ02, (ITEM 6), SLIGHTLY TO CLEAR J4

REV.	DESCRIPTION	BY	DATE
C	PER ECN #3403	[illegible]	11/92
B	PER ECN #3360	GRB	10/15/92
A	PER ECN #3317	GRB	8/12/92

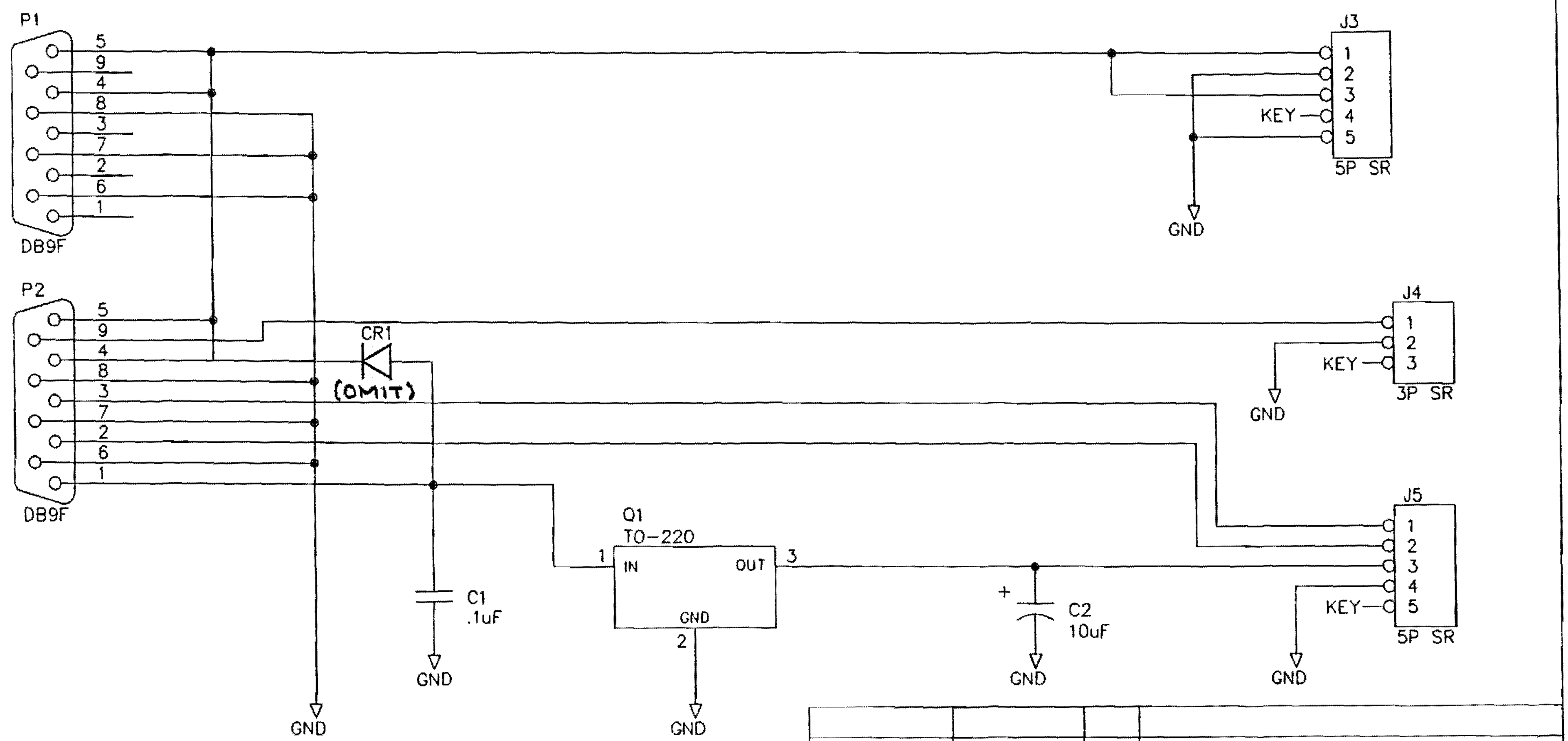
UNLESS SPECIFIED TOLERANCES ARE	DRAWN	SLP	3/92
.XX = ±	DESIGNED	SLP	3/92
.XXX = ±	CHECKED	[illegible]	[illegible]
ANGLES = ±	APPROVED	[illegible]	[illegible]

THIS DOCUMENT IS CONFIDENTIAL AND PROPRIETARY AND IS THE SOLE PROPERTY OF INVIVO RESEARCH INCORPORATED (IRI). IT IS NOT TO BE DISCLOSED TO ANY PARTY, REPRODUCED OR USED IN ANY OTHER MANNER WITHOUT WRITTEN CONSENT OF SAID COMPANY. INVIVO MAINTAINS THE RIGHT TO CHANGE ANY SPECIFICATIONS AT ANY TIME WITHOUT PRIOR NOTICE.

INVIVO RESEARCH INC.
4420 METRIC DRIVE SUITE A
WINTER PARK, FLORIDA 32792

TITLE PCA: AB50/AB50A
MRI SAT/CO2 POWER INT.

SCALE	SHEET	DWG. NO.	REV.
2:1	1 OF 1	C94C586	C



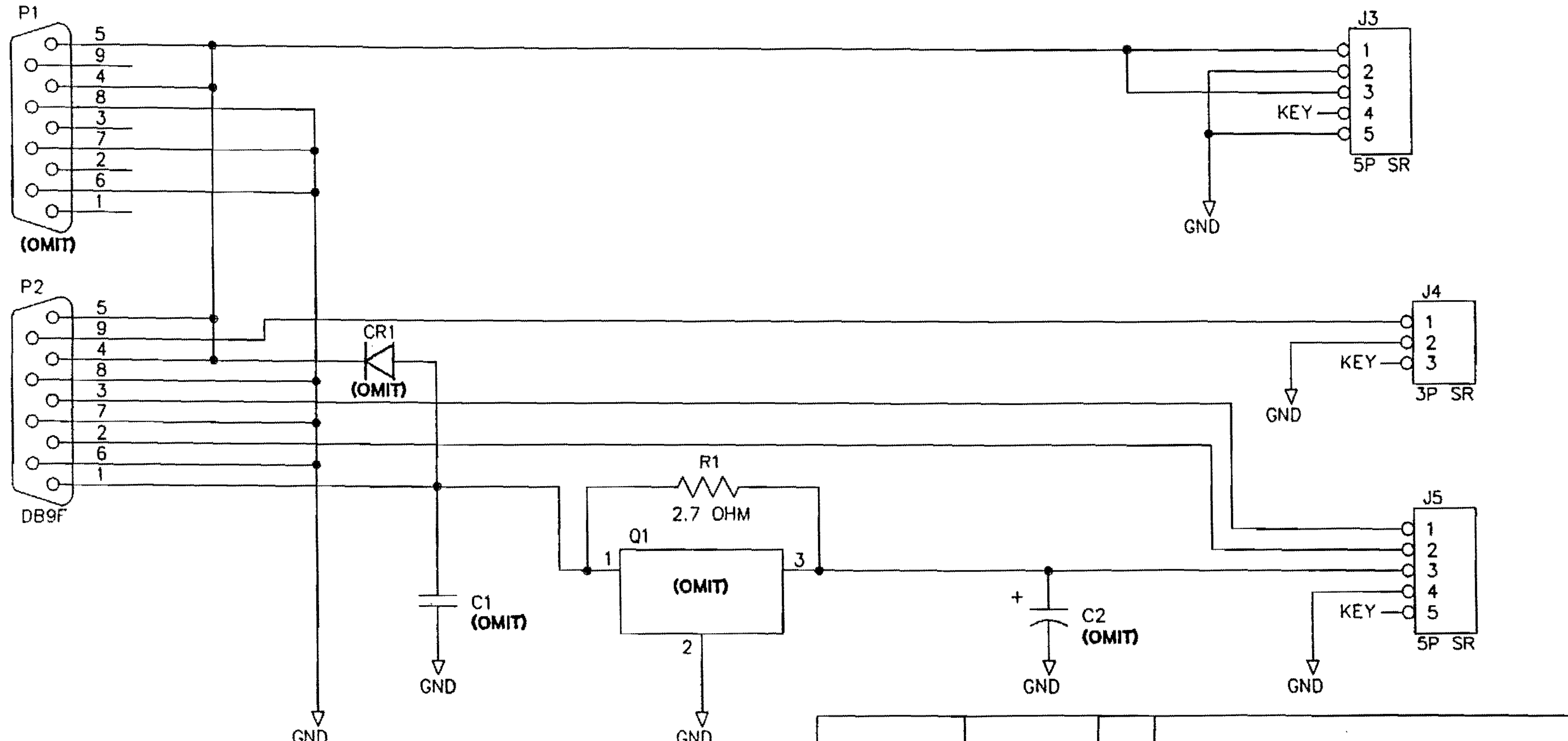
AB50

REV.	DESCRIPTION	BY	DATE
B	PER ECN #3403	GB	11/92
A	PER ECN #3360	GRB	10/92

ITEM / REF. DES.	PART NO.		QTY.	DESCRIPTION
UNLESS SPECIFIED TOLERANCES ARE .XX = ± .XXX = ± ANGLES = ±	DRAWN	SLP	2/92	INVIVO RESEARCH INC. 4420 METRIC DRIVE SUITE A WINTER PARK, FLORIDA 32792
	DESIGNED	RES	2/92	
	CHECKED	GRB	10/92	
	APPROVED	[illegible]	10/92	

TITLE SCHEMATIC: AB50/AB50A MRI SAT/C02 POWER INT. PCA

SCALE	SHEET	DWG. NO.	REV.
NONE	1 OF 2	C85B167	B



AB50A

ITEM / REF. DES.	PART NO.	QTY.	DESCRIPTION

UNLESS SPECIFIED TOLERANCES ARE	DRAWN	SLP	2/92
.XX = ±	DESIGNED	RES	2/92
.XXX = ±	CHECKED	RS	10/92
ANGLES = ±	APPROVED	RUF	10/92

INVIVO RESEARCH INC.
4420 METRIC DRIVE SUITE A
WINTER PARK, FLORIDA 32792

TITLE
SCHEMATIC: AB50/AB50A
MRI SAT/C02 POWER INT. PCA

SCALE	SHEET	DWG. NO.	REV.
NONE	2 OF 2	C85B167	B

APPENDIX B: SETTING THE INTERFACE OPTIONS

This appendix provides instructions for changing the Analog and RS-232 interface options.

B. SETTING THE INTERFACE OPTIONS

The Analog menu is used to set the voltages for the rear-panel analog outputs. The RS-232 menu is used to set the options for the rear-panel I/O Port.

> **NOTE**
>
> These options only need to be set if they have be changed inadverently by the operator. The factory default settings are **required** for correct 4500 MRI operation.

B.1 Setting the Analog Options

To change the Analog Options, enter the Analog Menu by pressing the OPTIONS control three times. The SYSTEM STATUS display will indicate **Analog**.

To exit the Analog Menu, press the CANCEL control.

<u>B.1.1 Setting Analog Output Volts.</u> Perform the following to set Analog Output Volts:

a. Press and release the OPTIONS control three times.

b. Ensure that the SYSTEM STATUS display indicates **Analog**.

c. Press one of the Arrow keys.

d. Ensure that the SYSTEM STATUS display indicates **Volt=xxV**.

e. "Volt" selects the output voltage for the analog waveform sent to the 3100 MRI and must always be set to 1V for correct 4500 MRI operation.

f. Press and release the CANCEL control to exit.

<u>B.1.2 Sending a Calibration Signal.</u> Perform the following to send a Calibration Signal:

a. Press and release the OPTIONS control three times.

b. Ensure that the SYSTEM STATUS display indicates **Analog**.

c. Press one of the Arrow keys.

d. Ensure that the SYSTEM STATUS display indicates **Volt=xxV**.

e. Press and release the OPTIONS control.

f. Observe that the SYSTEM STATUS display indicates **SaO2 xxx**. This feature has no effect because it is not used on the 4500 MRI.

g. Press and release the OPTIONS control.

h. Observe that the SYSTEM STATUS display indicates **Rate xxx**. This feature has no effect because it is not used on the 4500 MRI.

i. Press and release the OPTIONS control.

j. Ensure that the SYSTEM STATUS display indicates **Pulse xx**.

k. Use the Arrow keys to set the percentage of "full scale" voltage for the Pulse/Sync analog output.

l. Press and release the CANCEL control to exit.

> **NOTE**
>
> When you exit from these calibration sub-menus, the outputs return to their normal "full-scale" voltages. Each of these modes time out after 60 seconds, or may be exited by pressing the CANCEL control.

<u>B.1.3 Pulse Sync Output.</u> The rear-panel Pulse/Sync analog output can be set to send either the pulse waveform (the normal default) or a pulse-detect strobe. **This feature must always set to PR WAVE for the 4500 MRI.**

B.2 Setting the RS-232 Protocol Options

In addition to basic configuration of the I/O Port (baud rate, stop bits, etc., discussed later in this section) four protocols or "languages" are available.

To change the Protocol Options, enter the RS-232 Menu by pressing the OPTIONS control four times. The SYSTEM STATUS display will indicate **RS-232**.

To exit the RS-232 Menu, press the CANCEL control.

NOTE

These options only need to be set if they have be changed inadverently by the operator. The factory default settings are **required** for correct 4500 MRI operation.

B.2.1 Protocol Selection. Perform the following to change any or the four protocols:

a. Press and release the OPTIONS control four times.

b. Ensure that SYSTEM STATUS display indicates **RS-232**.

c. Press the UP or DOWN Arrow key to enter the RS-232 menu.

d. Use the Arrow keys to toggle through the protocol selections.

(1) **INVIVO**: Sets I/O port to Invivo serial communication protocol. **This option must be selected for 4500 MRI.**
(2) **Ohmeda**: Sets the I/O port to transmit and receive the Ohmeda 3700 serial protocol.
(3) **Nellcor 1**: Sets the I/O port to emulate a Nellcor pulse oximeter with N8000 or N9000 serial communications.
(4) **Nellcor 2**: Sets the I/O port to emulate the Nellcor (N- 100) fiberoptic protocol. For interface of waveform and numeric pulse and saturation data to external devices (e.g., SaraCap).

e. Press and release the CANCEL control to exit.

B.3 Setting the RS-232 Communications Options

To change the Communication Options, enter the RS-232 Menu by pressing the OPTIONS control four times. The SYSTEM STATUS display will indicate **RS-232**.

To exit the RS-232 Menu, press the CANCEL control.

B.3.1 Baud Rate Selection. Perform the following to change the Baud Rate Selection:

a. Press and release the OPTIONS control four times.

b. Ensure that the SYSTEM STATUS display indicates **RS-232**.

c. Press the UP or DOWN Arrow key to enter the RS-232 menu.

d. Press and release the OPTIONS control.

e. Ensure that the SYSTEM STATUS display indicates **Baudxxxx**.

f. Use the Arrow keys until the setting is 9600 Baud.

g. Press and release the CANCEL control to exit.

B.3.2 Stop Bits Selection. Perform the following to change the Stop Bits Selection:

a. Press and release the OPTIONS control four times.

b. Ensure that the SYSTEM STATUS display indicates **RS-232**.

c. Press the UP or DOWN Arrow key to enter the RS-232 menu.

d. Press and release the OPTIONS control two times.

e. Ensure that the SYSTEM STATUS display indicates **Stop Bits = xxx**.

f. Use the Arrow keys until the setting is 2 stop bits.

g. Press and release the CANCEL control to exit.

B.3.3 Parity Selection. Perform the following to change the Parity Selection:

a. Press and release the OPTIONS control four times.

b. Ensure that the SYSTEM STATUS display indicates **RS-232**.

c. Press the UP or DOWN Arrow key to enter the RS-232 menu.

d. Press and release the OPTIONS control three times.

e. Ensure that the SYSTEM STATUS display indicates **Par=xxx**.

g. Use the Arrow keys until the setting is OFF.

h. Press and release the CANCEL control to exit.

B.3.4 Character Length Selection. Perform the following to change the Character Length Selection:

a. Press and release the OPTIONS control four times.

b. Ensure that the SYSTEM STATUS display indicates **RS-232**.

c. Press the UP or DOWN Arrow key to enter the RS-232 menu.

d. Press and release the OPTIONS control four times.

e. Ensure that the SYSTEM STATUS display indicates **Character Length x**.

f. Use the Arrow keys until the setting is 8.

g. Press and release the CANCEL control to exit.

B.4 I/O Connection Pinouts. The following provides the signal to pin relationship for both models of the 4500 MRI.

B.4.1 Model 3109-1 System Ready Pulse Oximeter.

Pin Number	Signal
11,12,13	+14 to 28 VDC Input
14,15,16	Ground (Power)
9	RS232 Rx
10	RS232 Tx
8	Pulse Pleth + Waveform
6	Pulse Pleth - Waveform

B.4.2 Model 3109-3 Stand Alone Pulse Oximeter.

Pin Number	Signal
4,5	+14 to 28 VDC Input
6,7,8	Ground
3	RS232 Rx
2	RS232 Tx
9	Pulse Pleth + Waveform
1	Pulse Gate +

APPENDIX C: SOFTWARE REVISIONS

This appendix provides software revision historical information.

C. SOFTWARE REVISION

C.1 Obtaining Service

Before calling Invivo Customer Service or Technical Service for assistance with a problem with your oximeter, your need the serial number of your monitor and the software revision number. The serial number is located on the bottom of the monitor. To obtain the software revision number, press the OPTIONS key seven times, and the SYSTEM STATUS display will indicate **Rev.MxXX** (where XX is the revision number).

C.2 Software Revision History

(1) MX01: Initial Release.

(2) MX02: Improved pulse detection and sensitivity.

(3) MX03: Improved SaO_2 Filter (2,6,12) operation.

(4) MX04: Automatic reset of A to D bad detection, when caused by external interference.

(5) MX05: Make pulse bar correspond with beep tone.

(6) MX06: Add stand-alone features for 3109-3, Low Batt warning and automatic cutoff.

(7) MX07: Remove intermittent spikes on waveform output.

(8) MX08: Add Pulse tone modulation, save wave/sync selection, and remove display/menu for real time clock.

(9) MX09: Provides improved performance with new SaO_2 sensor.